THE MINERAL INDUSTRY OF TURKEY

BY L. NAHAI

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THE MINERAL INDUSTRY OF TURKEY[1/]

by

L. Nahai[2/]

INTRODUCTION

In two decades Turkey has emerged from the debacle of the Ottoman Empire to become one of the most modern nations in the Middle East. The numerous achievements of this period were remarkable in that they affected human and social, as well as economic, fields. Most of this progress was achieved by Turkey's unaided efforts and the utilization of domestic resources; however, since 1948 various United States aid programs[3/] have made significant contributions to increased agricultural and industrial output. Turkey's singleness of purpose in favor of a strong, independent, and prosperous republic has evoked universal admiration and encouraged the hope of stability in the Middle East.

Much of the development of the Turkish economy to date has been fostered by the State; however, with growing strength the leaders in 1950 considered the time appropriate to relax the nationalistic economic policy and permit private enterprise to play a larger role in increasing domestic output and raising the tempo of industrialization. In pursuance of this policy, laws encouraging investment of foreign capital in Turkey and others stimulating development of mining and petroleum enterprises were enacted in 1954. This new legislation, plus the cooperative attitude of the Turkish Government, have encouraged wide interest in the mineral resources of the country.

The purpose of this survey is to make available a concise presentation of essential data from which a preliminary appraisal of mineral-development potentials can be made. To present a more complete picture of the mineral resources of Turkey, minerals not of primary interest to investors are also included. The information on which the survey has been based was derived from published literature and observations in the field, supplemented by available official and unofficial data. No attempt has been made to cite sources in each instance because often the information has been compiled from more than one source.

1/ Work on manuscript completed January 1958.

2/ Near East specialist, Division of Foreign Activities, Bureau of Mines, Washington, D. C.

3/ Economic Cooperation Administration (ECA), Mutual Security Agency (MSA), Foreign Operations Administration (FOA), and International Cooperation Administration (ICA). United States financial aid to Turkey, excluding military defense assistance programs, totaled $619,400,000 during United States fiscal years 1949-56 and consisted of $324.3 million in grants and $129.1 million in loans; the remainder is conditional loan, direct forces support, technical assistance, and surplus commodities.

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SUMMARY

Major Features of Mineral Economy

A dozen or so minerals are mined in Turkey, and those of importance (other than construction materials) are coal, chromite, copper, and iron ore. The contribution of the mining industries to the gross national income still lags considerably behind that of agriculture and manufacturing. The most important mines are owned and operated by the State, although the share of private industry in mineral output is gradually increasing. Some mines are of medium size, but the majority are small and not mechanized. No properties are comparable in size and output to the large mines of the United States, and the majority of the deposits are medium to small.

Development of the industry is still hampered by expensive internal transportation, insufficient foreign exchange to purchase equipment for the mines, and inadequate basic geological information to guide development and planning.

Importance in the World and Domestic Economy

Turkey is an important world supplier of metallurgical chromite. Although the country produces exportable surpluses of manganese and iron ores, blister copper, a few other nonferrous metals and ores, and some nonmetallic minerals, the production of these commodities is not large enough to have world significance; however, mineral and metal exports are important sources of foreign exchange, and the mineral industry provides the solid fuels and many of the raw materials required within the economy. The country is by no means self-sufficent in minerals, and the need for petroleum imports imposes a heavy drain on its foreign-exchange resources. Base metals, iron and steel, and some industrial minerals and fertilizer raw materials must also be imported.

Outlook

Exploration for petroleum now underway by a number of private firms may lead to extension of present petroleum resources, and the prospects for finding new mineral deposits should be considered favorable within large areas of the country that have not yet been geologically mapped in detail. For example, recent prospecting has resulted in discovery of tungsten, molybdenum, and boron-mineral deposits.

GENERAL INFORMATION

Geography, Area, and Population

Turkey is a rectangular peninsula, roughly 1,500 kilometers long from east to west and 480 to 640 kilometers from north to south. It is bounded on the north by the Black Sea, on the east by Iran and Russia, on the south by the Mediterranean Sea, Syria, and Iraq, on the west by Greece and the Aegean Sea, and on the northwest by Bulgaria. The area (excluding marshes and lakes) of Turkey-in-Asia is 743,634 square kilometers (286,928 square miles) and that of Turkey-in-Europe 23,485 square kilometers (9,256 square miles). The total area of 767,119 square kilometers is comparable to the combined areas of Texas and South Carolina. European Turkey is separated from the rest of the country by the Bosphorus, the Sea of Marmara, and the Dardanelles - the only link between the Black Sea and the Aegean.

Turkey is mountainous country, with ranges paralleling the sides of the rectangle and increasing in elevation eastward. Behind a very narrow littoral along the

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Black Sea rise hills in the west and mountains in the east. The fertile river valleys draining into the Aegean Sea merge with hills and mountains inland. Taurus, the south Anatolian coastal range of mountains, reaches elevations of 2,700 to 3,000 meters (9,000 to 10,000 feet) in the southwest with the Kurdish Mountains in the southeast corner of Anatolia above 4,100 meters (13,500 feet). The border with Syria is mostly a dry plain, but east of Tigris the topography is again precipitous.

Central Turkey is a plateau (Anatolian), which is semiarid and rises in the east to several groups of mountains bordering on the Iranian and Russian frontiers. This plateau has an altitude of 450 to 580 meters (1,500 to 1,900 feet) in western Turkey. European Turkey (Thrace) has a gently rolling terrain, well-adapted to general farming.

The climate in general is temperate, although it varies widely, depending on the altitude and the position of the area relative to the seas. The coastal areas are warmer than the interior plateau and for the most part have an average rainfall of 76 centimeters (30 inches); the extreme eastern part of the Black Sea has almost a tropical climate, and 250 centimeters (100 inches) of rainfall is often recorded. The central plateau has rigorous winters and short growing seasons. The mountains surrounding the central plateau cause much precipitation along the windward slopes, so that many sections of central Anatolia report as little as 25 centimeters (10 inches) of rainfall. Severe winters and short summers characterize the mountainous section of the extreme east. Mean temperatures in different parts of the country are as follows:

	Winter, °F.	Summer, °F.
Near the Black Sea	45	70
Central Plateau	30	75

The 1955 population of Turkey is estimated at 24,122,000 (65)[4/] census. in 1950, the latest year for which data are available, 1,626,229 lived in Thrace (European Turkey) and 19,308,441 in Asian Turkey. Most of the people live in the western half of the country. Central Anatolia is the most typical of Turkish regions, with an ancient village culture and a hardy people. The population is homogeneous; over 85 percent of the Turks have a common tongue and ethnological background. However, the Kurds residing in eastern and southeastern Turkey are an important minority, numbering over 1,800,000.

Form of Government

General

Turkey is a republic governed under a constitution by a Grand National Assembly of around 540 deputies, elected every 4 years. The Assembly elects its presiding officers and the President of the Republic from its own members, also for a period of 4 years. The term of office coincides with the life of each assembly, but the President, the presiding officers, and the deputies may be reelected. There are two political parties - the Republican People's Party and the Democratic Party. The latter came to power for the first time in 1950 on a platform of gradual abandonment of nationalistic economic policy and encouragement of private enterprise.

4/ Underlined numbers in parenthesis refer to items in the bibliography at the end of this report.

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Administratively, the country is divided into 66 Il or Provinces (see fig. 1). The Il governors are appointed by the central Government for an indefinite period. Local government is under the administrative direction of the capital. The mining laws (see pp. 24-27) define the level at which a person engaged in mining will deal with the Government. Generally, he negotiates more with the central than with the provincial Government.

Agencies Concerned With Mineral Production, Consumption, and Trade

The Eti Bank, one of the State economic enterprises falling under law 3460,[5] is the most important mineral producer of Turkey. It was established in 1935 and has an authorized capital of TL 500,000,000, of which TL 232,010,000[6] is paid up. By law it is authorized to buy and sell mineral ores, operate mines and quarries, or participate in such enterprises. The bank's subsidiaries are Ereğli Kömürleri İşletmesi (Ereğli Coal Mines), Garp Linyitleri İşletmesi (West Lignite Mines), Şark Kromları İşletmesi (East Chromite Mines), Bakir İşletmesi (copper mines), Keçiborlu Kurkurtleri İşletmesi (Keçiborlu Sulfur Mines), and Keban Kurşun Madeni (Keban Lead Mine). The bank's Coal and Distribution Establishment has a de facto monopoly on the distribution and sale of bituminous coal and coke. Iron and steel are produced by the Turkish Iron and Steel Association, which is also a State enterprise falling under law 3460 and law 6559 of May 13, 1955. Since May 20, 1955, this corporation also operates the Divriği iron mine, formerly an Eti Bank holding.

Under the Ministry of Industry the Maden İşleri Genel Müdürlüğü (Mines General Directorate) administers the mining law and leasing.

Geological mapping and exploration for minerals are carried out by the Maden Tetkik ve Arama Enstitüsü (MTA) or Mineral Research and Exploration Institute, which was established in 1935 by virtue of Law 2804 of June 14, 1935. Effective July 1, 1957, MTA was transferred to the new Ministry of Industry, which was created by virtue of Law 6973 of May 27, 1957.

MTA, somewhat comparable to the Geological Survey in the United States, has prepared a geological and tectonic map of Turkey to the scale of 1:800,000 and completed 444 geological map sheets of 1:100,000. During its 20-year life the institute has amassed an impressive volume of information on the geology and mineral resources of Turkey and has been instrumental in finding many of the mineral deposits being worked today. Until passage of the Petroleum Law, MTA also had the exclusive rights for petroleum prospecting and production. The Raman and Garzan oilfields were discovered and developed by MTA.

Installation and rights of the MTA in the Raman-Garzan field and operation of the new Government-owned petroleum refinery in Batman were taken over by the Türkiye Petrolleri A.O. (Turkish Petroleum Corporation) set up in 1954 with an authorized capital of TL 150,000,000, of which 51 percent has been subscribed by the State. Except where specified to the contrary by company statutes, the Turkish Petroleum Corporation is governed by private commercial law. It is authorized to apply for petroleum licenses on the same basis as other applicants and, if necessary, to purchase, sell, and distribute petroleum products.

5/ Law 3460 of June 1938 established the administrative structure and operational procedure for certain economic establishments financed entirely by state investment.

6/ Turkish liras. The official rate of exchange is TL 2.80 = U. S. $1. or 1 TL = 35.7 cents.

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IL (PROVINCE) INDEX

1. EDIRNE	7. ZONGULDAK	13. TRABZON	19. BURSA	25. AMASYA	31. İZMİR	37. YOZGAT	43. BİNGÖL	49. BURDUR	55. GAZİANTEP	61. SİİRT
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4. İSTANBUL	10. SAMSUN	16. KARS	22. ÇANKIRI	28. GÜMÜŞANE	34. AFYON	40. MALATYA	46. AYDIN	52. İÇEL	58. ELÂZIĞ	64. SAKARYA
5. KOCAELİ	11. ORDU	17. ÇANAKKALE	23. ANKARA	29. ERZURUM	35. KONYA	41. ERZİNCAN	47. DENİZLİ	53. SEYHAN	59. DİYARBAKIR	65. ADIYAMAN
6. BOLU	12. GİRESUN	18. BALIKESİR	24. ÇORUM	30. AĞRI	36. NEVŞEHİR	42. TUNCELİ	48. MUĞLA	54. HATAY	60. MARDİN	66. UŞAK

FIGURE 1. - Administrative Divisions and Principal Roads of Turkey.

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Petrol Ofisi is a petroleum-marketing company established by cabinet decree in 1941. It came under the Ministry of Commerce and Economy but operated as a commercial organization importing and distributing petroleum products. In addition, it made suggestions with regard to fixing the prices of all petroleum products and determining the kind and amount of stocks in various localities. In 1955 it was reorganized as a limited company with a capital of TL 150,000,000, 51 percent of which has been contributed by the Government.

National Income and Annual Budget

National income estimates for 1948-55 have shown a regular increase, except for a 4.3-percent decrease in 1949. Turkey's gross national product in current prices rose from TL 10,067 million in 1948 to TL 17,137.4 in 1955, an increase of over 70 percent. In view of inflation, the actual increase has been less. In terms of 1948 prices, the figures for 1948 and 1955 are 10,067 and 13,099 million - a 30-percent rise compared with 70 percent in current prices. For the period 1950-55, mining composed a little over 1 percent of the gross national product.

Expenditures and revenues under the general budget and budgeted expenditures under the Annexed Budget for 1951-55 are given herewith in Turkish liras.

Government income and expenditures, 1951-56, million Turkish liras

Year	Revenues	Expenditures
1951	1,353	1,653
1952	1,652	1,823
1953	1,937	2,206
1954	2,185	2,381
1955	2,582	2,554
1956 (est.)	3,325	3,444

The division between ordinary and economic development (or investment) expenditures under the budget for 1950, 1954 and 1956 was as follows (million Turkish liras):

Year	Ordinary expenditure	Investment expenditures	Total budget figures	Percentage of investment as total
1950	1,276	279	1,555	18
1954	1,767	614	2,381	26
1956	2,459	985	3,444	29

Parallel to the increase in total budget, the share of investment expenditures has increased. During 1951-54 total expenditures for economic development amounted to TL 1,967 million compared with TL 698 million in 1947-50.

Revenue for the fiscal year 1956 was 204 percent that in 1950, whereas official wholesale price index increased 54 percent between 1950 and 1956. The sources of revenue comprise direct and indirect taxes and earnings from State-administered organizations. A breakdown of receipts for the fiscal year 1954 follows: Income, corporation and property taxes, 29.5 percent; custom duties, 8.9 percent; import transaction tax, 6.9 percent; manufacturing and banking-transaction taxes, 12.3 percent; various consumption taxes, road duties on fuel, and tax on monopoly goods, 19.4 percent; revenue from State-administered organizations, 8.2 percent; revenue from public domain and other taxes and duties, 11.6 percent.

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Transportation

Turkish economy is served by railroads, highways, and water transportation. The railroad network (7,600 km.) is fairly well developed and is perhaps the most important transportation means; it is operated by the Turkish State Railways, an independent, State-owned enterprise. Despite the steady rise in rolling stock the number of locomotives and freight cars is still inadequate. Highways of varying standards connect Turkey's major cities and towns. Most of them are surfaced with gravel or waterbound macadam, but the mileage of asphalt-paved roads is increasing. Transportation by roads is particularly important; these serve as feeders to railroads. Water transportation (passenger and cargo) along Turkey's coast is also important, particularly for hauling Zonguldak coal to other parts of the country. A large percentage of the cargo traffic is handled by small, privately owned motorboats. Marine passenger service between Turkish ports is a monopoly of the Turkish Maritime Lines. In addition to Istanbul, Izmir, and Iskenderun, which have modern port facilities, other ports along the Black Sea and Mediterranean are being improved.

MINERAL ECONOMICS

General and Economic Geology

Published literature on the geology of Turkey is fairly extensive. A bibliography prepared by E. Lahn in 1948 contains 519 titles; many more have been added since then. During the last two decades almost all geologic investigations have been carried out by the MTA, which has published a geologic map of Turkey in eight sheets, with a scale of 1:800,000. Accompanying the Izmir and Istanbul sheets are explanatory notes; similar ones will presumably be published for the other sheets. These explanatory notes attempt to integrate available information on the areas covered.

Much of the past work has necessarily been concerned with establishing the stratigraphic column and elucidating the tectonic features of the mountain ranges. Although some work has already been done in establishing metallogenic provinces and an attempt has been made to establish relationships between the tectonics and mineral deposits, this field has not been fully explored.

The alpine geosyncline extending across Europe and Asia through Turkey is an important determining factor in the geology of the country. In Turkey this geosyncline was confined between the Arabian block to the south and the Russian platform to the north. During alpine folding two main wings were formed, separated by the vast Anatolian plateau called the Intermediate Zone. On the inner borders of the main wings, folded beds encircle more or less ancient massifs. The two main alpine wings are not so clearly separated in the west and Aegean region, where a network of secondary folds, oriented in different directions (often north-south) and interrupted by massifs and depressions, extend between the two wings. These irregularities probably are due to the existence of three great massifs - Menderes of Western Anatolia, Cyclades of Aegean Sea, and the Rhodopes of Western Thrace.

Inasmuch as the alpine geosyncline in Turkey was in a confined area, vertical movements (Neogene to Quaternary) were more pronounced than in the border parts of the geosyncline, and these vertical movements created fault channels for eruption of volcanic rocks. The faults have determined the morphological frame of the country and are of two types. The dominant type generally parallels the folds, and the other is transversal, cutting the folds at various angles.

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Six tectonic units are recognized in Turkey and shown in figure 2; proceeding from north to south, they are Pontides, Anatolides, Intermediate Zone, Taurides, Iranides, and Border Foldings. An attempt has been made (28) to establish a relationship between the mineral deposits of Turkey and these tectonic units. The main wings of the Alpine Range in Turkey, the Anatolides and Taurides, contain virtually no metalliferous deposits. The explanation given is that these two wings represent the deepest parts of the alpine geosyncline characterized by horizontal orogenic movements of thick sediments virtually unassociated with intrusive or effusive rocks. To these sterile areas must be added the Anatolian-Iranian border fold zones - a structural unit that formed a subsiding basin on the borders of the Arab bloc which has not been affected by igneous activity other than Neogene-Quaternary basalts.

Only the Pontides, the Iranides, and the Intermediate Zone have significant commercial interest. Pyrite deposits are found in less basic rock of the Pontides in the southern limit of the unit and chromite veins in the ultrabasic rocks of Iranides that have been altered to serpentine within the northern limit. Mineralization, especially by chromite, is also concentrated on the border areas of the Intermediate Zone. Toward the interior are noted pyrometasomatic, hypo-, meso-, and epithermal deposits containing iron, tin, lead-zinc, cupriferous pyrite, antimony, and mercury. The central area of the Intermediate Zone is feebly mineralized.

Igneous rocks are very important in the geology of Turkey. They were both injected and expelled during prealpine, alpine, and postalpine periods. Prealpine rocks have been observed principally in the Intermediate Zone. They are mainly granites, and orthogneiss, a product of granite metamorphism. Important examples are the massifs of Kirşehir and Menderes. Igneous rocks of alpine age (Jurassic to Eocene) are more varied and range from ultrabasic to acid, although the acidic rocks are less important. Postalpine igneous rocks closely related to faulting (cratogenic) movement also are widely distributed in Turkey. They consist of Eocene basalt, Oligocene and Miocene andesites, trachytes, and rhyolites, and Quaternary basalts widely dispersed as small massifs and localized in a few large massifs along the border of the Arabian block and around rigid massifs of the Intermediate Zone.

The mineral deposits are independent of the postalpine igneous activity but are closely connected with Mesozoic and Eocene alpine intrusions and extrusions. Deposits of prealpine origin would have been more or less destroyed during the alpine orogeny.

Mineral Production

The exact value of minerals and metals produced in Turkey is not known. Excluding construction raw materials and cement, it probably amounted to about TL 450,000,000 in 1956 or about 2.4 percent of the 1955 gross national product. Coal and lignite composed 47 percent; chromite, 19 percent; copper, 14 percent; iron ore, about 3 percent; and other minerals, 17 percent.

With 1948 as 100, the index of mineral production in 1955 at constant prices was 204.9 compared with 161.3 for all industries. Production of minerals[7/] other than construction materials and of solid fuels for 1939-56, tabulated, respectively, in tables 1 and 2 and shown graphically in figures 3, 4, and 5, show a significant rise in the production of coal, copper, iron and steel, chromite, iron ore, manganese ore, and salt. Much of the increase has taken place during the last few years. Production rise has resulted from expansion programs of the Government to meet larger internal consumption requirements (coal, iron ore, iron and steel, and salt) and in response to larger world demands (chromite, copper, and manganese). The output of other minerals has not shown significant changes. There is no reason to believe that in the immediate future minerals and metals traditionally produced in Turkey will increase materially from the 1953-56 output. On the contrary, the

7/ All tons in the report are metric.

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TABLE 2. - Production of coal, lignite, coke, and briquets by Turkey, 1939-56
(Metric tons)

Source: 40 and 59.

Year	Coal		Lignite	Coke and semi-coke	Briquets
	Run of mine	Marketable			
1939	2,696,397	(1)	(1)	147,200	14,000
1940	3,019,458	(1)	229,200	260,600	24,500
1941	3,019,600	2,125,000	301,400	272,200	28,500
1942	2,509,600	1,813,700	390,400	279,600	22,000
1943	3,162,600	2,211,900	624,800	274,500	30,600
1944	3,554,300	2,493,000	673,700	306,200	34,800
1945	3,718,800	2,524,100	725,300	332,800	24,000
1946	3,830,200	2,525,600	603,500	355,700	12,600
1947	3,945,100	2,623,300	819,400	375,800	15,100
1948	4,021,800	2,669,000	1,010,100	394,300	7,400
1949	4,181,400	2,705,900	1,271,900	420,800	40,100
1950	4,360,600	2,832,200	1,214,500	433,000	29,400
1951	4,729,600	2,987,800	1,254,800	436,000	30,400
1952	4,846,300	3,010,300	1,375,400	499,800	36,700
1953	5,654,300	3,664,300	1,640,600	601,600	80,100
1954	5,714,100	3,577,500	2,100,500	642,300	91,900
1955	5,507,000	3,490,000	2,416,000	711,100	93,000
1956	5,888,300	3,717,700	3,010,000	605,500	67,500

1/ Not available.

Consumption and Trade

The relatively modest needs for minerals and metals in Turkey are satisfied primarily by iron and steel, aluminum, copper, lead, zinc, tin and bronze, and, other than construction materials, a few nonmetallic minerals, such as phosphates, sulfur, asbestos, and abrasives. Mineral fuels used are coal, lignite, and petroleum. The value of imports of minerals, metals (excluding manufactures), and fuels during 1952 and 1955 is shown in the following table:

Imports of minerals, metals, and fuels, 1952 and 1955

	1952		1955	
	Value in TL	Percent	Value in TL	Percent
Iron and steel	105,925,102	43.1	113,273,817	44.6
Nonferrous metals	27,513,006	11.2	19,162,288	7.5
Nonmetals	684,467	.3	3,462,258	1.4
Petroleum	111,881,000	45.4	118,194,455	46.5
Total	246,003,575	100.0	254,092,848	100.0

In line with decline of all imports in 1956, imports of the above commodities in 1956 were also smaller, the values for above categories, in the order given, being TL 81,381,517, TL 14,796,253, TL 2,009,362, and TL 100,593,224, totaling nearly TL 199,000,000. However, in view of development of the economy and the continued high level of construction and rising standard of living, long-range trends of mineral and metal consumption are upward. It is estimated that the 1956 apparent consumption of petroleum products is nearly seven times that of 1939. Domestic sales of bituminous coal (table 8) have also doubled between 1941 and 1956. Consumption data for other commodities are not available, but import figures for 1937-56 (tables 3 and 4) indicate that the consumption of many nonferrous metals has also increased. In the post-World War II period, imports during the 5-year period 1951-55 were larger than those of the 5-year period 1946-50 by 44 percent for aluminum, 49

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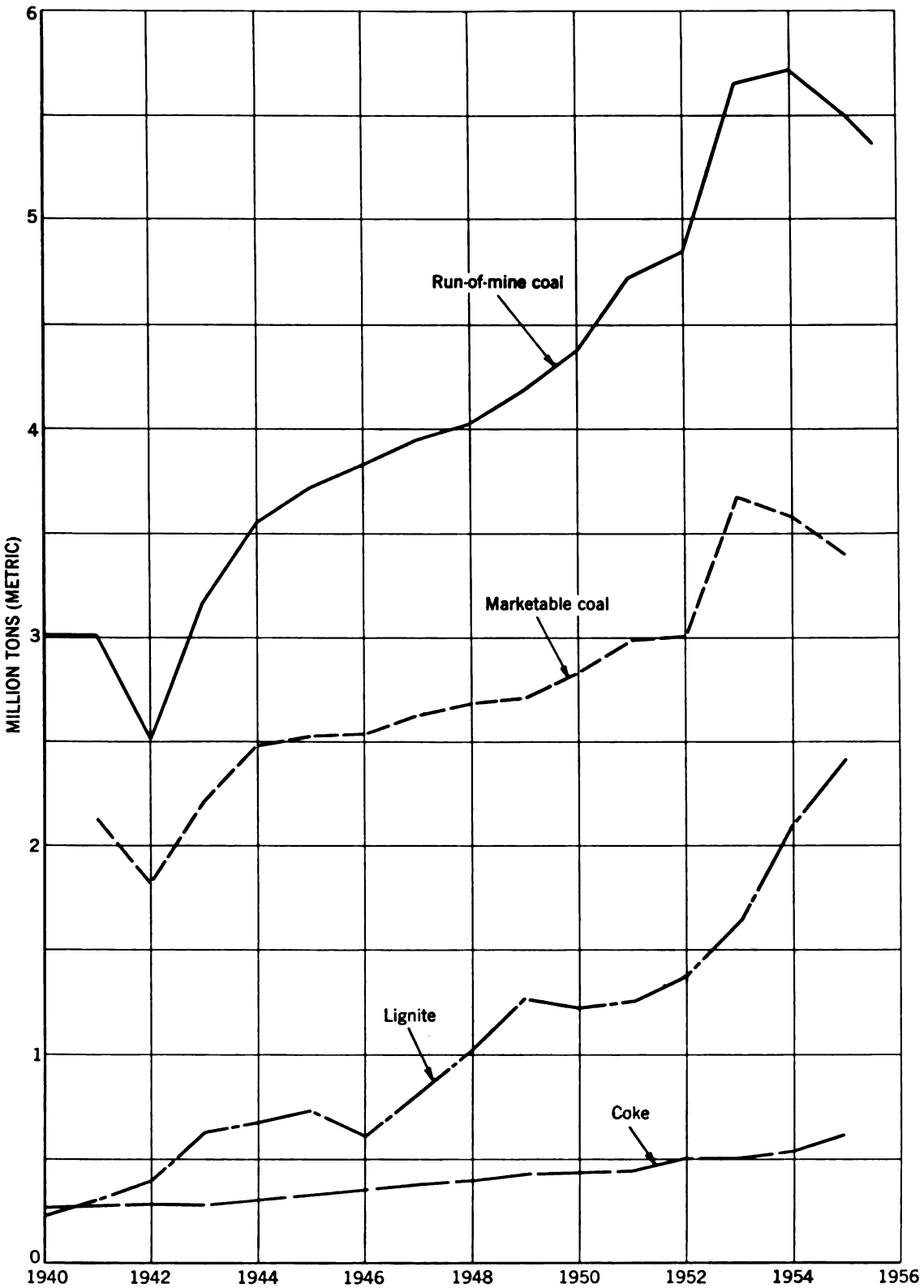

FIGURE 3. - Coal, Coke, and Lignite Production of Turkey, 1940-56.

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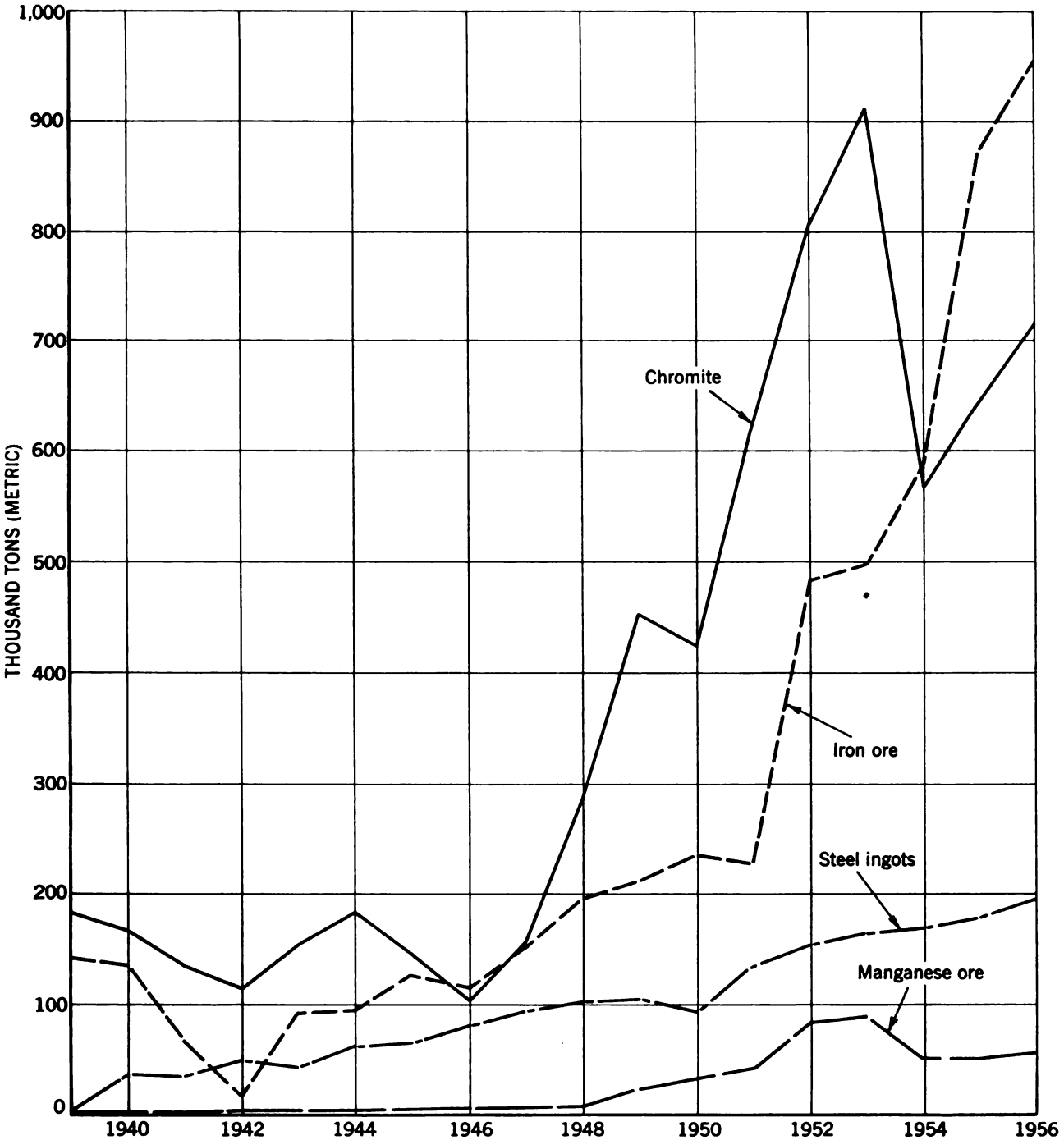

FIGURE 4. - Production of Iron Ore, Chromite, Manganese Ore, and Steel Ingots in Turkey, 1939-56.

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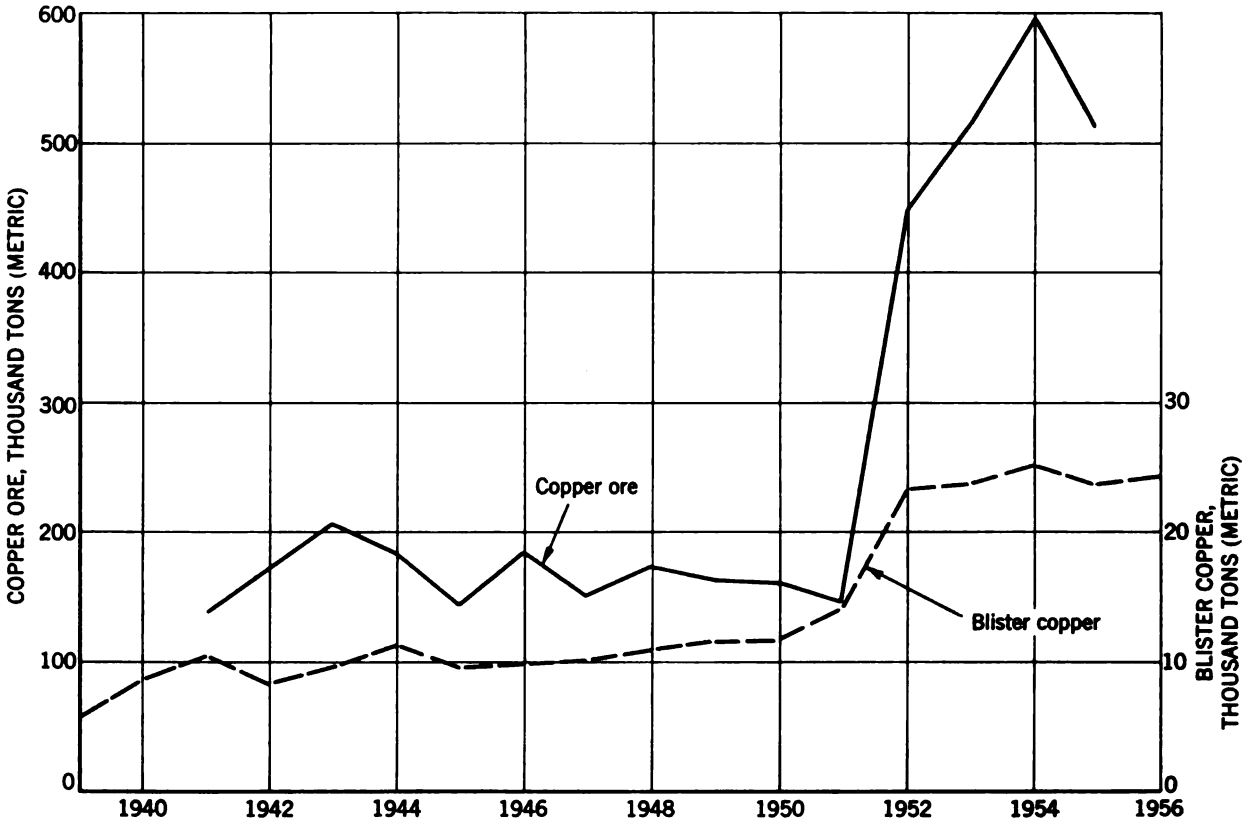

FIGURE 5. - Copper-Ore and Blister-Copper Production in Turkey, 1939-56.

percent for lead, 24 percent for zinc, and 26 percent for tin. Corresponding figures show a decrease of 7 percent for copper and 55 percent for bronze, presumably resulting from substitution of aluminum for copper and bronze in some uses, such as the manufacture of utensils. Spanning the same periods, increased consumption of iron and steel was met by larger imports and production shown respectively in tables 16 and 17.

Turkey's mineral exports are important in earning foreign exchange, but exchange so earned is insufficient to pay for essential mineral and petroleum imports. Minerals contributed 12.4 percent to the total of exports in 1955 and 15.7 percent in 1956. Metals and minerals exported from Turkey (tables 5 and 6) consist of chromite, iron, and manganese ores, copper and mercury, and a few nonmetallic minerals, such as boron minerals, emery, mangesite, meerschaum, salt, and sulfur. The values of metal and ore exports in 1951-56, respectively, were: 1951, TL 80,470,657; 1952, TL 127,562,464; 1953, TL 136,354,612; 1954, TL 82,958,302; 1955, TL 109,102,163; and 1956, TL 134,381,143. In 1956 chromite, copper, and iron ore accounted for 51, 31, and 8 percent, of the total; the 10 percent remaining comprised manganese ore, boron minerals, and others. Principal destinations are United States, followed by Western Europe, these 2 areas taking, in 1956, 60 percent of the tonnage and 69 percent of the value of mineral exports of Turkey. Turkey can increase its exports of antimony, lead and zinc ores, pyrite, boron minerals and salt on a modest scale and may also be able to export a few hundred thousand tons of coal to the Mediterranean area. But export markets for iron and manganese can be obtained only in periods of high world demand; emery, meerschaum, and mercury exports are irregular and depend on the vagaries of the market.

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TABLE 3. - Nonferrous metals imported into Turkey, 1937-56
(Metric tons)

Source: 61.

Year	Aluminum	Copper	Bronze	Lead	Tin	Zinc	Antimony	Nickel
1937	99	3,053	2	370	601	1,610	7	1
1938	119	3,090	2	1,460	636	2,329	42	2
1939	163	4,585	959	727	271	4,109	-	1
1940	71	362	8	233	802	501	-	1
1941	26	177	18	296	523	1,370	-	2
1942	130	260	34	50	180	2,154	-	2
1943	88	491	212	31	96	1,665	-	-
1944	22	252	114	27	409	327	3	3
1945	80	820	137	965	899	214	3	11
1946	168	2,137	294	1,419	202	2,613	11	34
1947	514	1,401	357	1,038	356	2,522	4	27
1948	281	1,221	480	656	755	1,372	10	16
1949	230	1,081	335	792	577	2,634	4	21
1950	559	1,188	945	2,273	1,110	2,311	-	52
1951	1,540	477	116	446	799	1,534	-	37
1952	632	641	377	2,372	635	2,642	-	24
1953	2,764	1,267	324	2,672	1,154	3,551	6	68
1954	1,784	1,306	248	2,634	523	2,701	-	23
1955	1,185	2,904	77	1,136	681	3,894	-	11
1956	697	1,184		2,381	656	1,564	-	1

TABLE 4. - Imports of principal nonmetallic minerals other than construction materials into Turkey, 1950-56
(Metric tons)

Source: 61.

	1950	1951	1952	1953	1954	1955	1956
Abrasives:							
Emery and carborundum	15	Insig.	Insig.	Insig.	1	11	1
Other[1]	437	1,218	840	460	237	141	-
Asbestos[2]	3	10	45	3	15	31	500
Clarifying clay	409	508	556	822	472	1,024	400
Cryolite	12	Insig.	20	12	-	-	1
Furnace slag	39	7	33	9	30	96	-
Graphite	126	97	53	53	29	34	46
Kaolin	4	89	103	128	26	52	381
Mica	1	1	Insig.	Insig.	Insig.	1	10
Phospahte rock	4,600	19,176	15,558	10,855	17,710	36,421	30,168
Quartz, feldspar, fluorspar ..	48	8	22	84	10	Insig.	137
Refractory clay[3]	330	1,631	259	159	65	66	73
Sulfur[4]	132	-	111	74	1,019	475	-
Talc	71	119	-	162	227	120	101

1/ Millstones, grindstones, pumice, and polishing stones.
2/ Unmanufactured; imports for other years were: 1937, 385; 1938, 240; 1939, 240; 1940, 68; 1941, 66; 1942, 9; 1943, 23; 1944, 3; 1945, 66; 1946, 53; 1947, 22; 1948, 5; 1949, 32.
3/ Excludes refractory bricks.
4/ Imports for other years were: 1937, 917; 1938, 2,538; 1939, 1,211; 1940, 4,051; 1941, 2,013; 1942, 2,880; 1943, 0; 1944, 405; 1945, 1,009; 1946, 3,801; 1947, 6,684; 1948, 2; 1949, 2,283.

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TABLE 5. - Metal and ore exports from Turkey, 1937-56
(Metric tons)

Year	Antimony ore	Antimony metal	Copper[1] metal	Chromite	Lead[2] ore	Mercury (flasks of 76 lbs.)	Manganese ore	Iron ore	Pig iron and ingot	Iron scrap	Zinc[5] ore	Other minerals
1937	1,400	-	511	198,459	8,393	585	-	-	-	1,598	24,999	4,669
1938	1,148	-	1,980	208,055	6,603	525	2,735	292	-	882	26,019	4,160
1939	1,660	-	6,332	192,842	10,392	323	177	-	-	1,615	20,524	15,202
1940	638	-	4,795	110,037	-	273	-	-	3,340	203	-	-
1941	50	-	990	86,208	-	235	-	-	10,084	-	-	-
1942	1,565	-	4,551	116,848	-	70	-	-	3,135	-	-	-
1943	-	-	9,632	80,828	-	212	-	-	6,903	66	-	-
1944	-	-	6,267	149,187	-	-	-	-	3,421	-	-	-
1945	-	-	338	62,682	-	43	-	-	631	-	-	-
1946	122	-	23,568	36,330	-	35	-	-	4,985	-	73	-
1947	300	51	5,432	183,777	-	-	30	-	27,465	4,231	7,118	-
1948	1,521	-	1,244	309,606	-	-	-	-	2,753	2,828	105	-
1949	272	173	7,230	353,246	[3]7,037	-	7,638	-	750	1,148	168	-
1950	1,457	96	6,316	353,603	-	-	18,547	-	-	2,711	-	500
1951	1,615	284	7,815	504,609	[3]1,076	-	46,202	-	[4]30,693	21,018	1,742	-
1952	406	-	16,667	626,407	103	73	80,479	95,412	19,351	42,375	1,263	-
1953	1,027	-	17,697	678,457	[3]1,944	70	66,777	111,585	-	11,199	55	1,524
1954	1,950	-	11,706	356,560	1,400	478	40,237	170,701	-	2,854	220	916
1955	1,187	149	12,054	559,583	-	505	31,771	342,255	19,973	3,209	597	-
1956	1,905	-	19,196	642,009	-	310	56,154	239,149	-	3,924	1,000	26,906

1/ Copper scrap was exported as follows: 283 tons in 1951; 51 tons in 1953; 900 tons in 1954; 356 tons in 1955; and 150 tons in 1956. In 1942, 1953, 1954, and 1955, 200, 4,896, 4,000, and 3,724 tons, respectively, of copper ore were also exported.
2/ Lead ingots were exported as follows: 1938, 100 tons; 1952, 500 tons; and 1954, 200 tons.
3/ Including 6,537 tons of zinc-bearing lead ore in 1949, 108 tons in 1951 and 950 tons in 1953.
4/ Including 2,000 tons of ferroalloys.
5/ Besides zinc ore, zinc scrap was exported as follows: 1948, 26 tons; 1949, 183 tons; 1951, 150 tons; 1955, 330 tons. In 1951, 227 tons of ingots and in 1952, 944 tons of plates were also exported.

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TABLE 6. - Nonmetallic minerals exported from Turkey, 1937-55
(Metric tons)

Source: Annual Foreign Trade Statistics, Turkey.

Year	Asbestos	Boracite	Emery	Crude magnesite	Meerschaum	Salt
1937	-	4,129	12,009	182	13	103,738
1938	1	4,622	8,370	-	15	56,688
1939	1	14,557	9,550	-	6	103,650
1940	4	5,380	9,893	-	11	11,126
1941	29	1,930	911	-	7	75
1942	115	10	10,525	-	5	75
1943	74	200	2,778	-	5	-
1944	8	-	56	-	5	-
1945	-	2,032	5,079	-	31	-
1946	-	3,048	10,342	-	9	53,569
1947	300	6,365	11,398	-	(1)	35,656
1948	174	6,063	9,729	1,997	5	29,199
1949	378	8,511	8,581	3,200	9	48,829
1950	29	10,151	8,337	600	27	-
1951	16	12,552	10,889	-	11	77,805
1952	1	12,161	6,237	600	12	82,698
1953	2	9,263	3,253	-	15	-
1954	-	17,482	8,593	-	22	-
1955	106	31,402	9,379	-	17	16,409
1956	-	3,393	8,698	-	14	55,801

1/ Accurate figure not available.

Mineral Position - World and Domestic

Turkey is an important world supplier of chromite. During 1950-56 it produced from 16.5 percent (1954) to 21.5 percent (1951) of the world output; the entire production is available for export and is marketed principally in Europe and the United States. Turkey also has exportable surpluses of copper and mercury; iron and manganese ores; pyrite; salt; small tonnages of ores of antimony, lead, and zinc; and a few nonmetallic minerals. In terms of world output Turkey's production of these nonchromic commodities is insignificant. The most important item is copper, production of which in 1956 equaled 0.7 percent of the world total.

In addition to the commodities mentioned above, Turkey is self-sufficient in various construction materials but has to depend entirely on imports for the modest quantities of nonferrous metals required by the predominantly agricultural economy. These metals are consumed in semifinished forms and in quantities too small for economic production. The country must also meet part of its iron and steel requirements from abroad. These imports are mainly in the form of rolled products. Among nonmetallic minerals, the most important deficiencies exist in potash and phosphate. In fuels, Turkey is self-sufficient in coal but must import almost all of its petroleum requirements at an annual cost of about $40,000,000 to $45,000,000. This dependence on imported petroleum may change as a result of exploration.

The metallurgical industry consists of 1 iron and steel plant, 2 copper smelters, and 1 small lead smelter. The iron and steel plant, with a capacity of about 150,000 tons of finished iron and steel products, meets (quantitatively) 50 percent of the country's requirements. No rolling mills are available for copper or any of the other nonferrous metals.

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Evaluation of Economic Factors Basic to Mineral Development

Mineral Resources

Estimated Turkish reserves of a few commodities are given herewith.

Commodity		Metric tons
Coal	(Measured	363,000,000
	(Indicated	460,000,000
	(Inferred	253,000,000
Chromite	Measured and inferred	3,000,000 to 4,000,000
Iron ore	do.	75,000,000 to 100,000,000
Bauxite	do.	10,000,000 to 20,000,000
Copper in ore	do.	350,000 to 400,000
Tungsten in ore	do.	43,000
Sulfur ore	do.	1,000,000 with 10 to 60 percent S

None of the reserves, except those of chromite and perhaps tungsten, are large enough to have world significance. Much of the bauxite is high in silica and iron, and of the tungsten reserves 70 percent carries less than 0.4 percent metal. Resources are adequate for a modest expansion of the iron and steel industry. More widespread utilization of subbituminous coal will help to meet the fuel needs of eastern Turkey, and prospects for discovery of additional petroleum resources are considered promising.

Distribution of the mineral deposits is not ideal. Metallurgical coal occurs only in the Zonguldak Basin, nearly 1,000 kilometers from the best iron-ore deposit. Iron-ore deposits closer to the coal basin cannot be utilized economically without prior beneficiation. Long-haul distribution of coal for other than metallurgical use is also very costly.

Evaluation of the chances for future discoveries is speculative rather than analytical. The Mineral Research and Exploration Institute has been engaged in geological exploration for a comparatively short time, and much of the work has been of a broad regional character. Detailed geological investigations and field mapping remain to be done in much of the country. The outlook for further discovery of ore deposits of sizes comparable to present known deposits may be considered fair. However, that will depend on active field exploration.

Labor Legislation and Manpower

Turkey's labor legislation is complicated and consists of detailed codes of law relating to employment, working conditions, labor-management relations, and social security. The basic law is No. 3008, of June 8, 1936. It provides that permanent

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employment for more than 1 year must be covered by written agreements, which must indicate the type of work, pay, duration of the agreement, etc. The Ministry of Labor is empowered by the Labor Law to establish local commissions to fix minimum wages in any place or for any type of work where such action is considered necessary. However, few commissions have been organized, minimum wages being limited to a few industries; establishment of minimum wages is, nevertheless, one objective of the unions.

Strikes and lockouts are prohibited. Elected representatives and (since 1950) unions, where applicable, represent the workers in dealing with employers or their agents in individual or collective disputes that may arise between management and labor. The management is obliged by law to discuss settlement proposals with representatives. Disputes are finally settled by arbitration and adjudication.

Mine workers must be Turkish citizens, although engineers, technicians, foremen, and skilled workers may be foreign nationals. An employment permit must be obtained in behalf of such foreign labor from the relevant ministry, and the employees are required to pay a so-called expert-training contribution at a rate to be fixed by the Government. These stipulations are not applied to an enterprise established in accordance with the Law for the Encouragement of Foreign Investment for such periods as the Foreign Investment Encouragement Committee certifies is necessary in efficient establishment, expansion, reactivation, or operation of such enterprises.

The Ministry of Health and Social Assistance has established regulations for protecting workers' health. Disability incurred on the job must be compensated up to 52 weeks at 75 percent of salary for persons with dependents with temporary disbility, or a 60-percent pension for permanent total disability. Insurance against accident and occupational diseases must be paid for by employers. This contribution ranges from 1/2 to 5 percent of the wages, the average contribution being 2 percent. The total cost of fringe benefits is about 12 percent of the base wage.

The labor force is estimated at 8,000,000, of which 12 percent is employed in industry and mining. The number of people engaged in the mineral industries is not known accurately but may be 50,000, of which some 31,000 are employed in the Zonguldak coalfield. The young labor movement in Turkey dates only from 1947, and unions cover only a small number of workers. Formation of unions and membership in them are optional. At the end of 1954 labor unions totaled 320, with an estimated membership of 200,000; the Zonguldak Coal Miners Union (membership estimated at 20,000) being the largest. Turkey's first national labor federation, the Turkish Confederation of Labor Syndicate (TCTU), was formed in 1952 and represents over 200 unions, with a total membership of about 150,000.

Labor is generally available and, with proper training, can be made more efficient. Shortages of some types of skilled labor, such as mechanics and good foremen, present a recruiting problem; in some sparsely inhabited sections of the country some time may be required before a labor force can be built up. In the coalfield of Zonguldak high turnover and absenteeism are attributable to the part-time employment of some workers, who more regularly are farmers and who regard mining as a supplementary occupation. This may be true also in other mining centers.

State mining activities have been managed by Turkish personnel, although, on the technical level, foreign technicians and consultants have been employed. As a result, management experience has been built up, although it may not necessarily be of the same caliber or type as American management skill. With the large number of students trained yearly in Turkish universities and abroad, availability and quality of technical personnel will improve.

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Generally the work week is 48 hours and includes time required for entering and leaving mines, quarries, or other underground places. Rest periods during working hours are not included in the working time.

Wages (1952) ranged from TL 225 ($80) to TL 1,000 ($357) per month for supervisory personnel; TL 175 to TL 750 for skilled workers ($62 to $268); and TL 110 to TL 500 ($39 to $179) monthly for unskilled labor. In the mining industry, during April 1955 the average miner received TL 4.5 to TL 5 daily or $1.60 to $1.79, with additional fringe benefits of TL 2.5 ($0.89) per day in the form of hospitalization, free meals, dormitory, etc.

Availability of Private Domestic Capital for Mineral Development

Although labor presents no serious problem in development of mineral resources, lack of private domestic capital willing to engage in this field has been a deterring factor and one of the reasons for Government participation in mining. Traditionally, domestic capital has been more attracted to such other investment fields as real estate and more recently the manufacture of consumer goods. Nonetheless, many enter the mining industry during periods of high prices, as illustrated by chromite in the early 1950's, but abandon it when price trends are reversed because insufficient earnings are plowed back to improve the competitive position of the industry. Furthermore, as is the case with other ventures, little of the available domestic capital can be converted into foreign exchange to buy equipment and supplies that must be imported. Although chrome exports constitute an important source of foreign exchange, many chrome producers are hampered in their operations because they cannot buy trucks and tires for transporting ore. To correct this situation, the Government recently ruled that a share of the sale of exported ore can be held by the exporter in foreign exchange.

As for large integrated mineral activities requiring erection of concentrators, smelters, and rolling mills, the Government will remain the principal source of domestic capital in the foreseeable future because the sums required cannot easily be found in the private domestic money market.

Mine Timber

Forest resources are unevenly distributed. Forests cover about 26 million acres and are concentrated along the sea coasts. About 2/3 of the country's need for wood and wood products are supplied domestically. Central Anatolia, wherein many of the mines occur, has sparse forest resources, but the mines are opencut. The coal mines, which constitute by far the largest underground mining operations, are in a forested area. Nevertheless, mine timber must be imported; it is estimated that in 1950, 70 percent of the consumption (210,000 solid cubic meters) was imported. The present cost of pit-prop imports is estimated at $7,000,000 annually. Imports are supplemented by domestic supply obtained mainly from the Inebolu area.

Electric Power

The installed capacity and power production in Turkey have recently been gradually increased. The installed capacity has increased from 32,780 kw. in 1923 to 537,900 kw. in 1954 and 610,000 in 1955. The power produced in 1953, 1954 and 1955 totaled, respectively, 1.2, 1.398, and 1.583 billion kw.-hr. In 1954 it was derived from the following sources: Coal, 63.6 percent; lignite, 19 percent; oil, 9.5 percent; waterpower, 6 percent; blast-furnace and coke gas, 2 percent; other, 0.2 percent. By 1960 the contribution of hydropower is expected to increase to 60 percent of the production.

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The amount of power consumed per capita was 54 kw. in 1953 and 61 kw. in 1954. In 1954, 60 percent of the total capacity was in municipal plants and 40 percent in industrial plants; production in municipal plants was 2.35 times that in industrial plants. Industry was the largest consumer, with 66 percent and northwest Anatolia the largest consuming area, taking about 70 percent of the total production.

Much of the power is generated by relatively small industrial and municipal plants not unified by a grid system. However, Turkey has important plans for power development. A grid system (154 kv.-a.) for northwest Anatolia, connecting Zonguldak, Istanbul, Karabuk, Ankara, Izmit, Kirikkale and other cities, and serving Turkey's most important industrial and mining areas was completed with United States financial aid in 1956. Feeding into the grid are power from the 60,000-kw. steam plant now operating at Çatalağzi in the Zonguldak area, the 80,000-kw. Sariyar hydroelectric plant which began supplying power in November 1956 and, the Çatalağzi extension plant (60,000-kw.), when completed. Through 1954 the United States contributed about $8,000,000 to construction of the Sariyar hydroelectric project and is also providing the foreign-exchange cost of the transmission line for the grid system.

In common with other industries, mining has produced its own power as required. In such mining areas as Ergani and Murgul, which are far removed from sources of fuel, transportation costs add materially to the cost of power production. For example, the cost of transporting 1 ton of coal to Ergani from Zonguldak (1,000 km.) is about $7. The Golcük power project, which has been surveyed, could serve Ergani and the Güleman mines if implemented.

Mining Supplies and Machinery

Mining machinery is not manufactured in Turkey. The Minneapolis Moline Co. has participated in establishing a tractor plant in Ankara, but the tractors are for agricultural purposes. The industry's needs for trucks may be met to some extent when the truck-manufacturing plant at Kirikkale comes into operation. An Austrian firm also proposes to construct a plant for manufacturing diesel trucks and tractors and diesel engines for industrial purposes. In addition to mining machinery, such supplies as drill steel, explosives, mine cars, and locomotives must be imported. There are two factories for the manufacture of explosives at Bakirköy and at Elmadağ near Ankara. The output of these plants is insufficient for all needs. The oxygen plant at Divriği meets the needs of this mine for explosives. Imports of explosives in 1956 consisted of 1,204 tons of prepared explosives and 23 tons of black powder valued at TL 2,219,706 and TL 140,101 respectively. Fuse and cap imports were valued at TL 582,497.

Imports of mining machinery and supply are hampered most by insufficient foreign exchange, which has necessitated control. Goods can be imported only on the basis of a license issued by the Ministry of Commerce and Industry. Mining machinery and supply mostly fall within the category, having a tariff scale of 5 to 10 percent of the value.

Transportation

Highways

Unfavorable terrain has made development of roads in Turkey slow and difficult. Furthermore, until the last few years work on internal transportation was concentrated almost exclusively on railways. The Government began a program of rehabilitation and expansion of highways at the end of World War II. Its objectives were to provide modern highways from the principal centers of population to the Mediterranean,

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Aegean, and Black Sea ports and all-weather roads to the agricultural and mining areas, so that the export products of Turkey may be transported to shipping points cheaply. Under the program, 3,400 km. of key roads have been constructed and 4,600 km. improved, including such important roads as that linking Ankara and Zonguldak and Ankara and the Mediterranean port of Iskenderun. The road network appears on the map showing the Il (Province) boundaries (fig. 1).

The United States Economic Cooperation Administration (ECA) program has made important financial and technical contributions to the road-building program. Funds totaling $21,000,000 financed the purchase of road-building equipment and the installation of repair shops. Ten shops in Turkey are now completely equipped for any type of major repair or reconstruction of road equipment, supplemented by 22 maintenance garages. ECA has also paid for the services of a special mission of the United States Bureau of Public Roads, which has been in Turkey since 1947 giving advice on the organization and administration of highway work and on personnel training. The United States contribution for highway construction has been matched several times over by Turkish funds. The total appropriation for highways during 1951-56 amounted to TL 1,269,108,000 ($453,253,000).

At the end of 1956 Turkey had 33,000 km. of all-weather roads, of which 3,500 km. was hard-surfaced, compared with 17,465 km. in 1950. Over 50 percent of the roads are maintained with modern road equipment.

Traffic on the highway is light and is not likely to increase at a rapid rate because vehicles, spare parts, and liquid fuels must be imported, and such imports are limited by available foreign exchange. However, the number of civilian transport vehicles rose from 22,000 in 1949 to 65,000 in 1955, and highway traffic (1,000 vehicles per kilometer) more than doubled from 557,248 in 1950 to 1,220,000 in 1956. Passenger traffic during the same period increased 4.5 times. The road-improvement program has resulted in a decline in freight rates from TL 0.29 per ton-kilometer in 1949 to an average of TL 0.20 in 1955. Remote agricultural areas of the country that formerly had no outlet have been opened.

Chromite mining in Turkey depends particularly on the existence of feeder roads and highways. Many of the mines are in inaccessible areas, and ore must be transported over gravel and dirt roads to main highways or railroads. Improvement of the road system has indirectly helped the chromite miners in some areas, but not to an extent as to reduce the disproportionate cost of transportation materially in the f.o.b. port cost of the ore.

Railroads

Turkey has a fairly well developed railroad network of about 7,600 km. of standard-gage (4-foot, 8-1/2-inch), owned and operated by the Government; in 1954, 11,800,000 tons of freight was carried by the railroads. The network consists primarily of single-track mainlines, with few branches. The railroad runs mostly through mountainous regions, necessitating many tunnels and steep grades. With few exceptions, all locomotives are coal burning. The trains are comparatively slow, and connections between cities often are not the most direct ones. The quantity of rolling stock does not suffice to meet the traffic demand, especially during the harvest (from September to November). However, this situation is being improved, partly by procurement of new rolling stock and partly by repair and construction of cars in shops in Turkey. The railroad network serves the important mining areas in general, and some mines (such as Ergani, Divriği, Zonguldak, and Soma) have direct rail connections.

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The Turkish Government allocated TL 501,000,000 ($178,929,000) during 1951-56 for rehabilitating the Turkish railroads, and the ECA-FOA contribution is believed to have exceeded $20,000,000. A large part of the ECA funds has been spent on three maintenance shops - at Adapazari, Eskisehir, and Sivas. The first two shops are used for repairing rolling stock; the Sivas shop produces freight cars. In addition to general rehabilitation, Government funds were spent on constructing the following lines:

Elazig-Mus-Tatvan (on Lake Van)	This line taps a potentially rich agricultural area; in 1955 the section between Genc and Mus (109 km.) was completed.
Narli-Gaziantep-Karkamis	Avoiding the bypass into Syria on the road to Iraq. Narli-Gaziantep opened in 1954.
Erzurum-Sarikamis	This line is being converted to standard gage; as of 1955, tunnels and bridges were completed as far as Sarikamis.
Ereğli-Armutcuk (14 km.)	Serving the important coal mine at Armatcuk; opened in 1954.

Also, electrification of the important lines between Istanbul and Ankara and Ankara and Zonguldak is planned.

The Turkish State railroad was under direct control of the Ministry of Communications until late 1953, when it became an independent State-owned enterprise. Under the new management the railroad will have greater latitude in running its affairs.

Ports and Shipping

Turkey has a long coastline; but natural harbors on the Black Sea or the Mediterranean are believed to be few. In 1954, about 9,600,000 tons of cargo (excluding timber and livestock) was loaded and discharged in Turkish ports of which nearly 4,000,000 tons was in coastwise shipping. In many ports cargo is conveyed to and from ships by lighters and open-top small craft, which number about 700. Delays occur in effecting the turnarounds of ships. Turkish ports do not have free zones.

Istanbul is Turkey's major port and handles a large share of the country's imports and exports; it is a focus for railways, coastal shipping, and ocean-going vessels.

The following features characterize the principal ports of Turkey other than Istanbul:

Izmir	The second most important port; it taps a large agricultural hinterland. Nearly 1,000 tons of ore can be loaded daily, using piers, but much less if lighters must be used.
Iskenderun	Turkey's most important Mediterranean port, which also serves eastern Turkey. This port handles (1956) 1,250,000 tons of cargo per year.

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Zonguldak — The most important Black Sea port (see under Coal) with annual capacity of 3,200,000 tons.

Mersin — This port which serves eastern Turkey is being developed at the cost of TL 98,000,000 to have an annual capacity of 1,200,000 tons.

Samsun — The second most important port on the Black Sea; anchorage is good but exposed, and severe storms are frequent in winter. Samsun has rail and road connections to the greater part of Turkey and will be made, at the cost of TL 70,000,000, into a port capable of handling 1,000,000 tons of cargo a year. In 1954 contracts were let for constructing 2 jetties of 1,500 and 3,000 meters, a 670-meter quay and warehouses, which will permit simultaneous handling of 4 Victory-type vessels.

In addition to the above facilities are several smaller installations of significance for the export of ore, mainly chromite. Information pertaining to these ports, the majority of which are considered to be open roadsteads, is given in appendix I.

A comprehensive program is underway to increase capacity and operational efficiency of the Turkish ports. During 1950-56, TL 240,000,000 ($85,714,000) was spent on this program, including a loan of $16,300,000 from the International Bank for Reconstruction and Development (IBRD) for major improvements in port facilities at Istanbul, Izmir, Samsun, Iskenderun, and Mersin. Upon completion of the program, the annual loading and unloading capacity of the ports will attain 12,750,000 tons, and handling services will be greatly improved. The total United States assistance to port and shipping is estimated to be about $12,000,000. The remainder is provided by the Turkish Government.

The Denizcilik (Maritime) Bank, a joint-stock corporation capitalized at TL 500 million, in which the Government holds 51 percent and the public 49 percent of the shares, acts as a holding corporation and administers all maritime services, of which the most important are shipping, ferries, ports, shipyards, and salvage. The bank is also authorized to engage in any banking operation directly or indirectly related to maritime transport.

Political and Legal Factors Affecting Mineral Development

Summary of Mining Law

A new Turkish mining law (No. 6309) was passed on March 8, 1954. The previous principal laws governing or affecting prospecting for and exploitation of Turkish mineral resources by private capital follow:

(i) Regulations on Ereğli Coal Mines Administration, dated April 26, 1867.

(ii) Lois des Mines (March 26, 1906), which abrogated the laws of 1886 and 1869 and is understood to have been modeled after the French law.

(iii) Regulations dated December 1, 1913, annexed to articles 39 and 58 of the Lois des Mines.

(iv) Temporary law dated April 30, 1915, which modified articles 5, 10, 17 and 23 of the Lois des Mines.

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(v) Law dated April 6, 1918, which authorized collection of military-equipment tax.

(vi) Law 792 (March 24, 1926), published in Official Gazette 341 of April 26, 1926, reserved to the Government exclusive rights for prospecting for petroleum and authorized the Government to use these rights itself or in agreement with private persons and firms. This law has now been replaced by the new petroleum law, No. 6326, of March 16, 1954.

(vii) Law 1794 (March 26, 1931), published in Official Gazette 1763 of April 1, 1931, which modified article 50 of Lois des Mines regarding proportional taxes on minerals.

(viii) Law 2804 (June 14, 1935), published in Official Gazette 3035 of June 22, 1935, which established the Mining Research Institute (MTA). The primary functions of MTA are the prospecting and exploration for new minerals. Deposits discovered by this agency may be reserved to the State for exploitation, or may be granted to private enterprise either by concession or by exploitation permit. In addition, the institute held, until passage of the recent petroleum law, exclusive rights for petroleum prospecting and production.

(ix) Law 2805 (June 20, 1935), published in Official Gazette 3035 of June 22, 1935, which established the Eti Bank.

(x) Law 2818 (June 14, 1935), published in Official Gazette 3036 of June 26, 1935, which modified certain provisions of the Lois des Mines and added some new regulations.

(xi) Law 3780 (January 18, 1940), Law for the National Protection, and amendments thereto, which contains articles applicable to mineral exploitation during emergencies.

(xii) Law 3867 (May 31, 1940), published in Official Gazette 4527 of June 5, 1940, which authorized seizure of the Zonguldak coal mines by the Government, and decree 2/14547 of October 15, 1940, published in Official Gazette 4644 of October 22, 1940, which effected that seizure.

(xiii) Law 4268 (June 19, 1942), published in Official Gazette 5139 of June 23, 1942, which abrogated certain provisions of the Lois des Mines, as well as two interim laws pertaining to mining.

(xiv) Law 6309 (March 8, 1954), the new Turkish mining law replacing previous legislation. This law has repealed items (i), (ii), (iii), (iv), (v), (vii), (x), (xiii) and article 7 of item (viii) and article 5 of item (ix). Regulations implementing the law were published in the Official Gazette in June 1954.

Some features of the new law follow:

Minerals are under the ownership and domination of the State and are not considered to be part of the land where they are found. Under the new law, three types of permits are issued: Exploration, operating, and concession. Exploration and operating permits are granted to a single Turkish citizen; to a legal person formed under Turkish laws where the statutes anticipate or specify mining; to a State

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economic enterprise or its organism, or to a public-service administration holding power in this respect. The concession is given only to a limited liability company or joint-stock company formed under Turkish laws and whose statutes include mining as an activity; to a State economic enterprise or its organism; or to a public-service administration. Thus, foreign capital participation is permitted as long as the company is established under the laws of Turkey.

An important aspect of the law is that the discoverer is given priority right to exploit his find, provided he can fulfill certain technical requirements. Furthermore, exploration and operating permits and concessions are transferable for the first time (provided no legal objections are perceived by the Ministry of Economy and Commerce) and can also be inherited. In case of inheritance, the rights and obligations cannot be divided among the heirs. The holder of exploration and operating rights may, after written application to the Ministry of Economy and Commerce, give liens on ores that have been produced or contract a mortgage on the mine as a guarantee for a debt arising from a loan contracted for the mine or for debts that he will contract.

The exploration for minerals is contingent upon obtaining an exploration permit, which is valid for 2 years, is not renewable, and is issued for 1 mineral only (except where 2 or more minerals occur together in an ore and have to be exploited at the same time). The area under exploration permit is limited to 2,000 hectares (1 hectare = 10,000 square meters = 2.471 acres). An operating right may not be greater than the exploration area (2,000 hectares). Applications for exploration permits are submitted to the office of the Governor of the Il (Province) in which the exploration area is located, but the permits are issued by the Ministry of Economy and Commerce. Exploration must be carried out under the direction of a mining engineer, a mine technician, or a geologist; and the holder of an exploration permit must give (by notarized statement) the name and address of the technical person who accepts direction of the exploration activity.

The holder of an exploration permit may apply, by means of a written request, for the operating right to a mine he has discovered. The discoverer of a mine has priority in obtaining the first operating right. The Ministry of Economy and Commerce will decide whether the mine will be the object of an operating permit or operating concession. That decision depends on the ore reserves and ore quality, the economic and technical conditions, the importance of the mineral to the country's economy, and the length of time in which the reserves may be depleted. The Ministry prepares the operating contract for the mines as discovered, showing the technical, economic, and financial conditions and the amount of guarantee to be paid by the holder of the operating permit. The contract is given to the discoverer. However, if he does not have the necessary qualifications, he must transfer his rights within 1 year. For transfer of the operating right, the discoverer is compensated as follows:

(a) The portion of the expense incurred during the exploration period that cannot be covered by sale of ore.

(b) Allocation of 1/2 percent of the value of ore serving as the basis for establishing the State's royalty (see below).

The effective period of an operating permit cannot be less than 10 years or more than 15 years and cannot be renewed. Exploitation, as set out in the technical report and contract, must start within 1 year of registration of the operating permit. The operating concession is granted by a decision of the Council of Ministers

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and is for an effective period of not less than 40 years and not more than 99 years. The Ministry of Economy and Commerce decides, on its own initiative, or upon application by the holder of the operating permit who demonstrates an important development, if the mine operated under a permit should become the object of a concession.

The holder of an operating permit or concession is required to appoint a responsible manager. Technical activities should be carried out under supervision of a mining engineer; and at least one mine technician or mine foreman must be kept on location.

The State's royalty is levied at the rate of 1 to 5 percent (depending on the kind of minerals) of the f.o.b. sale price at the port of export for ores sold abroad, and of the average sale price realized by several mining operations in a locality for ores sold within the country. In case of a concession, the State's royalty will be decided by the Council of Ministers. If the holder of an operating permit or concession does not produce the quantity of ore which he has engaged during each calendar year, he is still obliged to pay the State's royalty for the full amount engaged.

The owner or occupant of the land necessary for all installations above or below ground in operation of a mine is obliged to concede such land (for temporary occupation or expropriation) to the holder of the mine operating permit, within the framework of certain provisions of this law. The operator must pay compensation to the landowner. If the land needed for operating the mine is under State possession and ownership, it shall be allocated to the mining operation, without charge, by the Council of Ministers, upon recommendation of the Ministry of Economy and Commerce. Exploration on desert or unforested land, under ownership of the State, does not come under provisions for guarantee and compensation.

The areas and mines on which no exploration permits are given because the Mineral Research and Exploration Institute (under article 7 of law 2804) has taken them over for exploration purposes, may be left closed for private exploration for 2 years from the effective date of this law. Opening of these areas and mines after the 2-year period shall be advertised in an official manner, and from the date shown in the advertisement the area shall be open for private application.

Summary of Petroleum Law

For nearly 2 decades Government policy was that petroleum resources must be developed only by the State, and no foreign capital was permitted to participate in exploration or exploitation of petroleum. This was in line with the general economic policy of development of industries by the State that has characterized modern Turkey. Two factors brought about relaxation in this respect. The Democratic Party, which won the election in May 1950, had a platform for encouraging private capital investments, the limitation of Government ownership of industries to those of a "basic" or public-utility character, and the transfer of other Government-owned industries to private enterprise. Added to the change in the economic philosophy of the Government was the increasing consumption of petroleum products and the difficulty of financing the imports. It thus became urgent to try to develop domestic petroleum resources speedily and bring about some degree of self-sufficiency.

In November 1952 the Council of Ministers decreed that legislation be sought on the basis of which outside interests would be invited to participate in exploration and exploitation, and specialists familiar with oil legislation would be engaged by the Turkish Government to assist in framing new petroleum laws. The reaction of the large international oil companies to this new oil policy was favorable, and early in 1953 the Turkish Ministry of State Enterprises approved applications filed by several

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private oil companies for permission to conduct surface reconnaissance in advance of the passage of new petroleum legislation. Meanwhile, an American expert was engaged as a consultant on future oil policy and on petroleum legislation. A new petroleum law (No. 6326) was enacted in March 1954 and amended as law 6558 of May 13, 1955.

The law allows foreign oil companies to explore for and produce petroleum on an equal basis with companies incorporated in Turkey. The country is divided into 9 regions shown in the map, figure 6; 2 of them are partly closed at present. Applications for exploration and exploitation are classified as permits, licenses, leases, and certificates. A permit is for geological investigation and may be granted for a specified period covering all or part of the land described in the application; it is nonexclusive. A license confers on the holder the right to do geological investigation; to do geological investigations for the purpose of determining his own petroleum prospects, as though a permittee, outside the license area; to conduct exploratory or development drilling and to produce petroleum from the area, exclusive of others; and to apply for lease after having made a discovery. Only license application by a permittee may be granted. A lease confers on the lessee the exclusive right to explore for, develop, and produce petroleum from the lease area, as long as the lease is in force; the right to conduct any petroleum operation that may be conducted under a certificate (such as transportation or refining).

A license area may not exceed 50,000 hectares, and a person existing by virtue of law may at the same time hold at most 8 licenses in a district. The term of a license shall be 6 years; but, provided a licensee continues to explore with diligence, the terms of his license may be extended from time to time, not exceeding 2 years at a time. A lease area shall be at most 25,00 hectares, and a person may hold lease areas totaling not more than 150,000 hectares in 1 district at 1 time. The term of a lease shall be 40 years from the effective date; it may, under certain conditions, be renewed for a total additional term not exceeding 20 years.

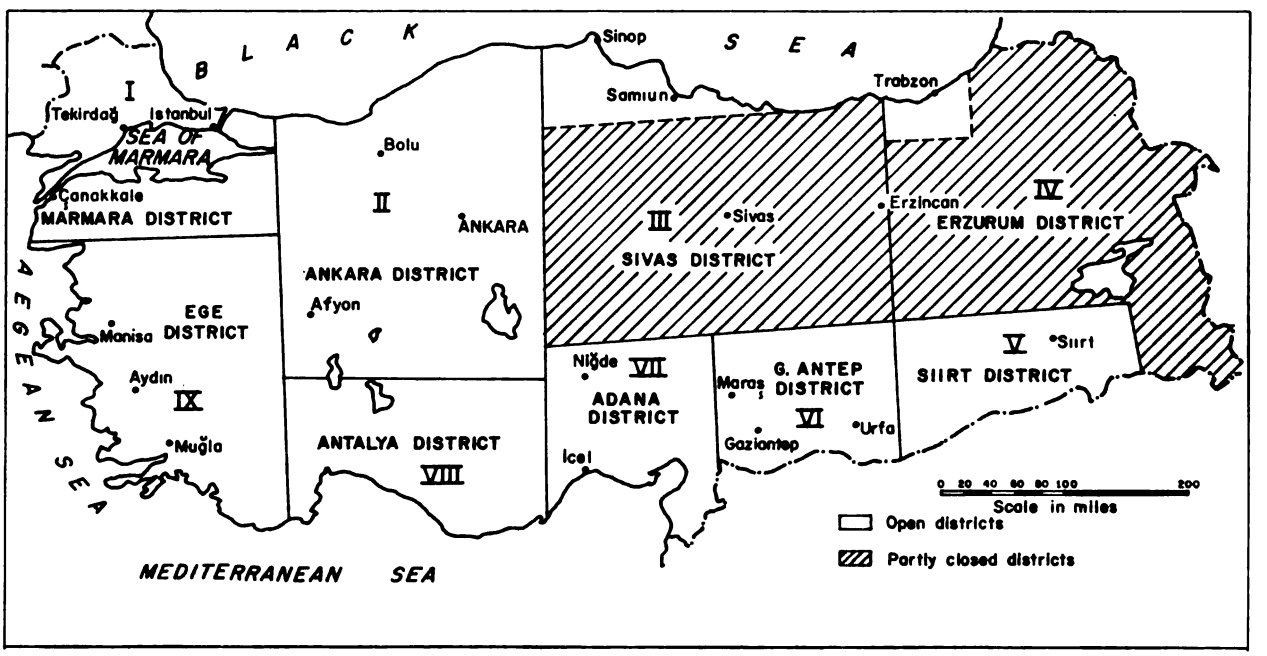

FIGURE 6. - Petroleum Districts of Turkey, As Determined by Decision 4/2774 of the Council of Ministers, in Accordance With Art. 45 of Petroleum Law 6326.

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Licenses and leases are subject to annual rents per hectare, varying with the number of years after the start of the license or lease. For licenses the rent is 0.5 to 3.00 TL per hectare and for leases 3 to 8 TL. For any taxation period royalty (State's share of petroleum produced) paid by a licensee who has made a discovery on his license area shall be credited to the rental payable by him thereon for that period.

A licensee or lessee shall be liable for a royalty of one-eighth of the petroleum produced and stored from the license or lease area but not including petroleum used by him in his petroleum operations or injected into the same or another reservoir stratum. Royalty, payable in cash, shall be calculated at the average market price[8/] of petroleum at the wellhead. Producers are exempted for 25 years from March 1954 from payment of import duties on materials and machinery used and from export tax on petroleum exported.

In computing income and profits subject to taxation, the holder of a petroleum right shall be allowed to deduct from his gross income a reasonable amortization allowance; depletion allowance; rentals and royalties and interests on indebtedness; losses due to damage to or destruction or loss of property; and other items, such as exploration expenses and overhead, and costs of consumer goods purchased by him or services rendered to him.

A holder of a petroleum right is subject to: (a) A normal tax, which is the sum of the tax levied on his net income and profits under the laws in force, and the tax to be paid on behalf of the shareholders on their income and profits through withholding or otherwise to be credited against their taxes; (b) after once having recovered the value in his capital-asset base plus the remaining losses to be carried forward, a surtax on his income and profits amounting to the balance left after deducting it from 50 percent of his net income and profits, the normal tax and other direct taxes, rentals, and royalties, fees, customs and other import taxes and dues paid or payable by him to the State for the taxation period.

State Mining Activities

The Turkish State, operating through the Eti Bank, is the largest producer of minerals and metals in the country; and, until passage of the new petroleum law, petroleum exploration and production were carried out exclusively by the Government. The most important mining enterprises - Zonguldak coal mines, West lignite mines, Güleman chrome mine, Divriği iron mine, Ergani and Murgul copper mines, the Keçiborlu sulfur mine, and Keban lead-zinc mine - are owned entirely by the State. These mines produce, respectively, all of the bituminous coal, 70 to 75 percent of the lignite, 25 to 30 percent of the chrome ore, 70 percent of the iron ore, all of the copper ore and sulfur, and some of the lead ore. Some of these properties were acquired by purchase of concessions given previously to foreign companies; others were started by the Government as a result of exploratory work by its mineral agencies. Both copper smelters at Ergani and Murgul and the Karabük and Kirikkale steel plant are also Government-owned and produce all the copper and iron and steel. The hitherto dominant role of the State in mining has been due to factors already mentioned under Capital.

8/ Article 3 (25 (b) defines "wellhead price" as the market price less all expenses, including direct and indirect taxes - apart from the normal tax and surtax - and custom dues, involved in bringing petroleum, other than refined products, from the wellhead to the place of delivery in Turkey.

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Government Attitude Toward Foreign Capital

Although it is not Government policy to turn over going mining operations to private enterprise, Turkey welcomes domestic and foreign private capital for finding and developing new deposits. Measures designed to implement the Government attitude to and improve the legal climate of foreign investment are the Foreign Investment Encouragement Law (approved January 18, 1954) and the Petroleum and Mining Laws. Certainly, in petroleum, many foreign companies have taken advantage of the new investment climate.

Investment-insurance guarantees authorized by the Mutual Security Act of 1954 will be given, under certain conditions, to American firms making investments in Turkey. Such guarantees are available for the transfer of earnings or profits of an approved project or as compensation for the sale or disposal of facilities related to the project, provided that the Turkish Government offers a similar guarantee. Under Turkey's Law for Encouragement of Foreign Investment, the Government is authorized to give such a guarantee under certain circumstances. Guaranty against loss by expropriation or confiscation is not available for Turkey, but the budget subcommittee for the Ministry of Finance recently recommended that the Ministry conclude an expropriation guaranty agreement with the United States.

Ordinary companies are given the right to export 10 percent of their invested capital yearly and profits up to 10 percent of their invested capital. By the new Foreign Investment Encouragement Law, however, there is no limitation on repatriation of capital or profits for new approved investments. The exchange rate used is that of the prevailing foreign currency involved at the time of transfer, or the official rate in the case of the capital.

To be accepted under the investment law, a foreign investment must tend to promote economic development of the country; operate in a field of activity open to Turkish private enterprise; and entail no monopoly or special privilege.

At present, foreign investment in mineral industries is principally in petroleum exploration; 10 foreign companies are participating. The total investment of these companies is not known. Other prospective petroleum investments are for construction of refineries (see under Refinery).

Foreign investment in nonfuel mining (cash and kind) may amount to less than 3/4 million dollars. Borax Consolidated, Ltd., a British company, has been producing boron minerals for many decades. Newmont Mining Co., a United States concern, was engaged in exploration activities during 1954-57.

Three German firms are investing in the iron and steel industry for producing tubes and pipes and expanding the Kirikkale steel mills. The total investment of these German firms is about $1,850,000. Investment of some 3/4 million dollars by a French firm for the production of ferrochrome also can be added as foreign investment in the metallurgical industry.

Taxation

For a company intending to invest in Turkey, detailed study of the tax structure of the country is necessary, with the expert advice of tax lawyers, because, as often is true, brief presentation and simple interpretation of tax laws are not feasible. It is particularly important to determine the type of tax liability - limited or unlimited - of foreign employees of a concern carrying on business in Turkey. From the point of view of taxation, the advantages and disadvantages of incorporating a

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business in Turkey and registering it as a domestic concern or establishing a direct branch without assuming local corporate identity must be determined in individual cases with advice of competent lawyers. The petroleum law embraces special tax features for companies engaged in petroleum exploration and production; these have already been referred to under Summary of Petroleum Law.

All real persons, Turkish or foreign, are subject to the Income Tax Law (No. 5421), which was enacted in June 1949 and became operative with the calendar year 1950. Tax liability may be unlimited (universal); that is, the taxable income of the real person would include not only his earnings and income accruing in Turkey but also earnings and income accruing abroad. Under limited taxation, only the portion of income in Turkey is taxable. All real persons domiciled in Turkey, whether of Turkish citizenship or otherwise, are subject to universal taxation. Foreign businessmen who reside permanently in Turkey or who have lived in Turkey for more than 6 months during a calendar year are subject to universal taxation, unless they qualify for limited taxation under the Income Tax Law. However, they may deduct from the amount of tax for which they are liable in Turkey any income taxes paid in their own country. Limited taxation applies to foreign companies and permanent reresentatives in Turkey of foreign companies who qualify under the provisions of the Income Tax Law. There is no tax treaty with the United States for avoidance of double taxation.

The personal income tax is levied at the following rates: 15 percent on the first TL 2,500; 20 percent on the next TL 5,000; 25 percent on the next TL 10,000; 30 percent on the next TL 20,000; 35 percent on the next TL 20,000; 40 percent on the next TL 20,000; and 45 percent on the next TL 22,500. Assessed incomes exceeding TL 100,000 are taxed at the rate of 35 percent. The foregoing rates are subject to a general increase of 5 percent for unmarried taxpayers.

Corporations domiciled in Turkey must pay a tax on all of their corporate earnings in Turkey or abroad. Corporations not domiciled in Turkey pay a tax only on their earnings in Turkey. The rate of corporation tax for corporations, special partnerships with shares, limited liability companies, cooperative societies, and all foreign companies of the same nature is 10 percent of the net profit. A further requirement is the withholding of 15 percent of the net profits after payment of the 10-percent corporation tax, or 13-1/2 percent of the total net profits. The amounts withheld are deductible from the income tax that their shareholders are required to pay.

Tariffs and Other Import and Export Restrictions

Turkey does not grant general tariff and trade concessions to new industries. An exception was made in the petroleum law permitting importation of all equipment needed, free of custom charges. With a few exceptions, Turkish custom duties are on an ad valorem basis. Duties on machinery are moderately low - 5 to 20 percent; but there is a transactions tax on all goods manufactured abroad and imported. For most manufactured goods the tax amounts to 18 percent of the c.i.f. value plus custom duties and is levied by the customs authorities at the port of entry. In general, the tax is not levied on goods exempt from customs duties. Adequate provisions are made for industries to import raw materials, within limitations of available foreign exchange; such materials would not be subject to the import transaction tax unless they are the product of a manufacturing process.

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Exchange Regulations

No foreign-exchange earnings remain the property of an individual or corporation. Foreign exchange may be sold freely at designated banks but may not be purchased or used without the permission of the Ministry of Finance. All enterprise, foreign or local, is subject to this law. Exporters are required to sell their receipts in foreign exchange at authorized banks. Provisions for repatriation of earnings and capital have already been mentioned.

RELATIONSHIP OF AREA TO UNITED STATES

The mineral industry is a significant branch of the Turkish economy and in time is likely to assume greater importance. The United States is interested in a strong, dynamic Turkish economy; during the last decade it has made substantial contributions toward achieving this goal. In a narrower sense, Turkey's mineral economy is important to the United States for the following reasons:

As a Source of Strategic and Other Raw Materials

Turkey is an important supplier of metallurgical chromite to the United States. Copper, manganese ore, and emery are other mineral commodities furnished to this country, although the tonnages involved are not comparable with those of chromite.

United States chromite imports from Turkey since 1938 (table 22) show average annual imports of 77,331 tons during 1940-45, which increased significantly to average annual imports of 325,726 tons during 1948-53. In 1953 imports exceeded half a million tons and constituted 25 percent of United States general imports of chrome of all grades - 28 percent if Metallurgical-grade chromite is considered. Although, because of fall in demand, 1954 and 1955 imports were considerably less than the maximum attained in 1953, this does not reduce the significance of Turkey as a source of this important commodity. The reserves are substantial, and the mines can satisfy an export demand on the 1953 scale for several years.

Except for 1941, 1945, 1948, and 1951, Turkey has exported copper to the United States every year since 1937. These exports have varied from a minimum of 400 to a maximum of 17,250 tons and averaged 3,879 tons for the years since 1937 when exports have been reported. Although, compared with total consumption in the United States, Turkish exports are small, the dollars earned from the trade are important to Turkey in improving its balance of payments position.

Turkey has figured only recently in the mining and exportation of manganese ore. Nevertheless, in 1952 and 1953, respectively, 80,479 and 21,773 tons of manganese ore were exported to the United States. Although its reserves are not considered large, Turkey may continue to be a modest supplier of manganese ore.

Occurrences of tungsten and beryl have recently been examined and preliminary tests for fissionable material made in several localities. It is too early to predict the future role of Turkey as a producer of these strategic materials normally imported by the United States, but the potentialities should not be overlooked.

As an Outlet for Profitable Employment of United States Capital

Past policy regarding the development of basic resources and industrialization discouraged foreign capital investment; however, economic policy has changed significantly, and the Government is now interested in attracting foreign capital. This

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policy has found expression in important new legislation pertaining to mining and petroleum and has created a more favorable and receptive atmosphere for foreign capital. Already several American petroleum companies and one mining company have shown interest in developing petroleum and mineral resources. Prospects are perhaps more favorable in the petroleum industry partly because capital in this industry is more adventurous and partly because several promising petroleum structures are already known. But in mining, there are also possibilities for investing capital in nonferrous minerals and in such ferroalloy deposits as chromite and tungsten. Unfortunately, favorable metallogenic areas have not been defined, and private capital must be ready to pay for expensive preliminary reconnaissance and exploration.

As Providing Opportunity for Employing United States Consultants

Several Turkish mining executives have been educated in the United States. During the last few years, under the various assistance programs, many American engineers and consulting firms in Turkey have been giving assistance and advice in developing the coalfields and solving specific problems. As a result, the mining industry in Turkey is now acquainted with the high standard of proficiency of American mineral engineers and geologists and appreciates the advantages of American mining practice. An opportunity is therefore provided for employment of American consultants in advisory capacities. However, two factors limit the hiring of American personnel: The higher scale of American as compared with European salaries and the shortage of dollars in Turkey.

As a Market for United States Mineral Products

Turkey's imports of mineral products consist mainly of iron and steel, aluminum, base metals (such as copper, lead, tin, and zinc and their alloys), a few nonmetals, and petroleum products (see Consumption and Trade).

As regard iron and steel, imports from the United States (table 19) were relatively large (averaging 40,300 metric tons a year) during 1946-50, when West European steel mills had not fully recovered from the effects of World War II and up to 70 percent of total Turkish iron and steel annual imports came from the United States; however, since 1951 the combined imports from Belgium, Luxembourg, Germany, France, the United Kingdom and others have added to considerably more than those from the United States.

Turkey normally imports from European countries a large percentage of its aluminum and base-metals requirements. Among nonmetallic minerals, carborundum and other abrasives, asbestos, and sulfur have been imported; import data for these commodities (table 5) show that the tonnage imported annually is small; and, as regards sulfur, Turkey is now self-sufficient. The source of petroleum products other than lubricants is the neighboring countries of the Middle East. Reviewing past trade practice, Turkey cannot be considered an important outlet for mineral and metal commodities produced in the United States.

As a Market for United States Mining Equipment and Supplies

Data on imports of mining machinery into Turkey are not available. During the period April 3, 1948, to June 30, 1954, under the ECA-MSA-FOA programs, construction, mining, and conveying equipment worth about $33,000,000 was exported from the United States to Turkey. In addition, considerable imports of this type of equipment came from Europe, financed by counterpart funds. All imports were not for the use of the mining industry; and the total does not represent normal requirements, because during this period Turkey was carrying out a large program of accelerated development and

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industrialization. Before the program referred to above was undertaken, Turkey was already importing mining machinery from the United States on its own account. For instance, the concentrating mills at the Ergani copper and Güleman chromite mines were American designed and fabricated. American-made compressors, drilling equipment, and mechanical shovels are also seen in the Eti Bank mines, which have not received United States assistance. A widespread acquaintance with and acceptance of American mining machinery is therefore evident. To estimate the normal requirements of Turkey's mineral economy for mining equipment is difficult. The accompanying table, giving the tonnage of ore obtained by surface and underground mining for an average year and the modes of mining and transportation, may be of assistance in appraising the potentialities of the market.

Surface operations

Type of mineral	Production (metric tons)	Probable waste rock broken (metric tons)	Technical methods, transportation, etc.
Chromite	900,000	2,500,000	Ore broken by drilling with compressed air and blasting, transported in mining area in cars hauled by locomotive or hand trammed, and by trucks; moved from mine to railroad station or port by ropeways, trucks, and in 1 or 2 instances by narrow-gage railroad.
Copper ore	500,000	650,000	Overburden removed by mechanical shovel, broken by drilling with compressed air and blasting, transported to mill by cars, hauled by diesel locomotive (in case of Ergani mine) or transported aerial tramway (at Murgul). On both properties ore is concentrated by flotation and smelted in blast and reverberatory furnaces.
Iron ore	500,000	1,000,000	Overburden in largest mine is stripped mechanically. Liquid oxygen used for breaking. Ore crushed and transported to shipping point by aerial tramway.
Manganese ore	90,000	250,000	Method of breaking varies. Manual operations.

Underground operations

Type of mineral	Production (metric tons)	Probable waste rock broken (metric tons)	Technical methods, transportation, etc.
Coal	5,500,000	7,000,000	Broken by drilling and blasting, pneumatic picks, etc. Within mine coal moved by conveyors and track haulage, to washeries by railroad, or aerial ropeway.
Lignite	1,600,000	2,000,000	Little blasting required. Lignite moved by conveyors and track haulage within mine, and in 1 instance by aerial ropeway to washery.
Quarry operation	(1)	2,000,000 (est.)	
Total		15,400,000	

1/ Not available.

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except for 1942 and 1955. Maintaining production during World War II, when procurement of machinery and spare parts became extremely difficult, was the result of ingenuity and abnormal effort of the mine operators. However, by 1947 conditions at the mines required a major degree of rehabilitation if a serious decline in output was to be prevented. This rehabilitation demanded, to a large extent, complete replacement rather than repair of existing installations. With ECA aid, development and equipment of the mines have been underway since 1948. When the program is completed, the annual production of marketable coal (in 1960) is expected to be increased to 5,800,000 tons and production cost reduced by TL 3 per ton. This target figure represents perhaps the optimum production that may be expected from the Ereğli field. The entire mining area will be divided into three main sectors - the Çatalağzi group, the Kozlu group, and the Ereğli group.

TABLE 7. - Run-of-mine coal production, by mine groups, Zonguldak, Turkey, 1941-52 and 1956 1/
(Metric tons)

Source: 40 and 59.

Year	Kandilli	Kozlu	Üzülmez	Gelik	Kilimli	Total
1941	315,900	887,000	904,600	429,700	482,400	3,019,600
1942	268,800	697,800	748,500	400,400	394,100	2,509,600
1943	217,200	886,400	1,005,800	591,100	462,100	3,162,600
1944	296,700	982,100	1,075,100	655,800	544,600	3,554,300
1945	331,700	973,800	1,070,700	786,400	556,200	3,718,800
1946	365,600	876,100	1,175,800	853,700	559,000	3,830,200
1947	399,900	893,900	1,179,000	884,300	588,000	3,945,100
1948	394,700	957,800	1,212,400	828,100	628,800	4,021,800
1949	346,500	995,200	1,275,400	912,600	651,700	4,181,400
1950	320,900	1,085,100	1,260,900	1,032,300	661,400	4,360,600
1951	413,700	1,070,200	1,401,400	1,168,600	675,700	4,729,600
1952	421,300	1,022,800	1,440,500	1,273,600	688,100	4,846,300
1956	605,400	1,216,400	1,659,600	2,406,800	(2)	5,888,300

1/ Breakdown not available for 1953-55.
2/ Not available.

Consumption and Trade

Coal consumption has increased considerably during the last decade, as can be seen from domestic sales of bituminous coal (table 8). The principal consumers (with their 1956 percentages in parentheses) are the State railways (26.5), Karabük iron and steel plant (21), gas plants (13.5), power (12.5), merchant marine (10.2), copper smelters (6.6), cement (4.9), textile and other factories (3.9) and heating (3.1). Total coal marketed by the Ereğli Kömürleri Isletmesi in 1956 was 3,413,800 tons valued at TL 127,788,018 or TL 37.43 ($13.37) per ton. Comparable figures for the previous year were 3,390,400 tons worth TL 117,202,215 or TL 34.57 ($12.35) per ton. It was planned that Turkey export annually 500,000 metric tons of washed bituminous coal in the Mediterranean area market; however, domestic consumption has increased more rapidly than production and has prevented the exportation of so much coal. Turkey's consumption in the next few years may exceed domestic production. The decline in coal exports is shown in table 9.

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TABLE 8. - Sales of bituminous-coal in Turkey, 1941-56
(Metric tons)

Year	Domestic sales	Exports	Total
1941	1,754,800	26,200	1,781,000
1942	1,619,600	700	1,620,300
1943	1,862,200	100	1,862,300
1944	2,075,600	10	2,075,600
1945	2,140,900	20	2,140,900
1946	2,117,700	178,900	2,296,600
1947	2,271,700	112,600	2,384,300
1948	2,336,900	1,100	2,338,000
1949	2,514,300	1,500	2,515,800
1950	2,549,400	300	2,549,700
1951	2,536,800	25,600	2,562,400
1952	2,663,600	132,800	2,796,400
1953	3,539,700	7,300	3,547,000
1954	3,438,600	0	3,438,600
1955	3,390,400	0	3,390,400
1956	3,414,400	610	3,414,400

TABLE 9. - Coal exported from Turkey, by countries of destination, 1937-55[1/]
(Metric tons)

Source: 61.

Year	Brazil	France	Greece	Hungary	Italy	Syria	Other	Total
1937	34,656	91,266	50,772	14,278	41,247	9,790	51,216	293,225
1938	18,700	138,822	11,996	13,082	58,725	23,463	77,537	342,325
1939	27,772	78,818	2,558	1,077	21,201	5,047	70,570	207,043
1940	-	-	2,862	-	-	-	40,626	43,488
1941	-	-	12,032	-	-	4,915	9,246	26,193
1946	-	59,515	-	-	-	-	117,148	176,856
1947	-	52,167	5,770	-	17,073	-	37,582	112,592
1948	-	300	-	-	-	-	826	1,127
1951	-	25,141	120	-	-	-	350	25,611
1952	-	117,588	-	-	261	-	14,991	132,840
1953	-	7,192	-	-	-	-	100	7,292

1/ 1942, 729 tons; 1943, 70 tons; 1945, 18 tons; 1949, 1,481 tons; 1950, 340 tons, 1956, 610 tons; 1954 and 1955 none. Lignite exports were: 1940, 1,225 tons; 1941, 500 tons; 1944, 10 tons; and 1952, 95 tons. In 1940, 2,824 tons of anthracite was also exported.

Ereğli-Zonguldak Field

The Government bought the concessions of the Société Française d'Heraclée in 1936 and of other private operators in this area in 1940 and placed them all under the fincancial direction of the Eti Bank in the latter year.

The coal basin borders the Black Sea roughly for 50 kilometers and extends, with interruption, from Çamli to Çatalağazi (see fig. 7). Width is variable, with a 3-km. minimum. The beds outcrop within 2 or 3 km. of the coast, but this distance increases eastward. The 52 seams belong to the Lower, Middle, and Upper Carboniferous, which underlie folded and faulted Cretaceous rocks. In the entire Zonguldak field about 42 percent of total production is derived from seams with thicknesses within the limit of 80 centimeters to 1.5 meter. Total thickness divided by number of seams varies

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from 1.4 to 2.2 meters. The composition of the coal varies according to whether it is Middle or Lower Carboniferous. In the region being mined, the Middle Carboniferous dominates, and the total number and thickness of workable seams are 16 and 40 meters, respectively. Thickness of individual seams is extremely variable, from 0.45 to 8 meters, and the pitch is steep, though in the bottoms of the synclines the seams become almost horizontal. As an average, the Middle Carboniferous coals carry 20 to 32 percent ash, 30 percent volatile matter, and less than 1 percent sulfur and are coking. Lower Carboniferous coal, developed especially in the western end of the field between Çamli and Kireçlik, has a lower ash content (16 percent) and a higher amount of volatile matter, can be marketed without washing, but is poorly coking. The calorific value of run-of-mine coal varies from 4,500 to 6,000 calories per kilogram, equivalent to 8,100 to 10,800 B.t.u. per lb.

The seams occur in synclines and frequently are cut by faults. This factor, with the steep dip and variable thickness of the coal, makes difficult application of machinery to the mining of the deposit.

Evaluation of reserves is made difficult by the complex geology and stratigraphy of the region and faulting of the formations. Stratigraphic study and the structure of Ereğli-Zonguldak coal basin indicate that the basin extends to the south and east. The productive coal beds may thin out toward the east, but the possibility of finding productive beds in the region south of the fault bounding the present coal field is considered favorable. In the light of current information, total reserves of the field are given as 1,076 million tons, of which 68 million is for the Kandilli area, taken to a depth of 800 meters below sea level, and the remainder, 1,008 million tons, is for the Zonguldak-Kozlu area, taken to the - 1,200-meter horizon. Of the grand total, 363 million tons are placed in the "measured" or "in sight" category, 460 million are classed as "inferred" and 253 million as "indicated." Producing mines are as follows:

Western district measured reserve, 30,000,000 tons

Çamli	5 miles northeast of Ereğli.
Kandilli	Kandilli has a thick seam of coal (Lower Carboniferous), virtually vertical; it is worked underground by an inclined shaft. An aerial ropeway was completed in 1953 between Kandilli and Armutcuk, junction of the railroad to Ereğli. A colliery is developed with a shaft at Armutcuk. Daily output, 3,000 tons.

Eastern district measured reserve, 330,000,000 tons

Kozlu group:	Roof and seam conditions and faulting in Kozlu make mining difficult. Conditions are similar to those in Pennsylvania anthracite mines. Uzum Mehmet shafts 1 and 2 have been sunk to serve Kozlu mines. Shaft 1 is 625 meters deep and 6.5 meters in diameter; shaft 2 is 520 meters deep and 6.5 meters in diameter. It is equipped with skips for coal hoisting. Operating levels are located at 300, 400, and 500 meters. Daily production from Kozlu mines is 5,000 tons of which 2,000 tons is obtained from the Çaydamar mine.
Çaydamar	2 new shafts are being sunk, making a total of 4 new shafts in the Kozlu mines.

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Kasaptarla	Shaft mine.
Incirharmani and Ihsaniye	Both mines are a few kilometers inland, southeast of Kozlu; they are equipped with skips of small capacity and connected to each other by an 800-meter tramway. Ihsaniye coal goes by ropeway to Incirharmani washery.
Kilimli group:	Daily production, about 4,000 tons.
Kilimli	Directly east of Zonguldak. In Kilimli mine are relatively few faults, and rock conditions are generally good, but mine is wet. Mining method resembles room-and-pillar. Kilimli is a shaft mine.
Karadon	Karadon mine has 2 shafts, 1 with skip for coal hoisting and 1 with cage for use of men. Relatively few faults occur in Karadon mine, and rock conditions are generally good; but the mine is very wet.
Dağbaca and Ingazi	Both mines are about halfway between the coast and the Asma, Dilaver, and Gelik mines.
" "	
Uzulmez group:	Daily production, 4,500 tons.
Asma and Dilaver	Southeast of Zonguldak and a few miles inland. Asma is a shaft mine. Conditions at Asma and Dilaver are about the best in the field because the seams are on lighter pitches, faults are less frequent, and conditions are generally better.
Gelik	Daily production, 4,000 tons. Southeast of Zonguldak, a few miles inland. Gelik is an adit mine. An aerial tramway connects mine with Asma.

No one mining method can be applied to all fields, and the procedure has to be varied to suit local conditions. To obtain 100-percent extraction the longwall method has prevailed; however, more recently the room-and-pillar method is also practiced to reduce mining costs. In very steep seams the coal is won by multiple levels. Owing to the mountainous nature of the terrain, no coal is won by strip mining. In seams that have a dip of more than 30° the coal moves by gravity to levels below; in flatter seams shaking conveyors deliver the coal to the levels. Tramming of cars in coal galleries is manual, and transportation in main haulage levels is by diesel locomotives.

The mining cost varies with the mining method and the conditions prevailing in each property. The longwall method is more expensive, in labor, because it requires a large number of men to build packwalls, set timbers, and attend to various other types of work. No detailed information is available on the present mining cost and its breakdown. In 1950 mining cost was believed to be TL 35 ($12.50) but may be higher now because of increase in the wage scale.

Coal production by mine groups and output per man for the whole basin, employment and other pertinent data for 1941-56 are given in table 10. The output per man is lower than for most European countries, as is shown in the accompanying table:

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Output of coal, 1956
(Metric tons per man-day)

	Underground workers	Underground and surface
Belgium	1.160	0.841
France	1.645	1.078
Saar	1.818	1.158
West Germany	1.564	1.190
Netherlands	1.496	0.963
United Kingdom	1.601	1.250

The low productivity is due partly to the nature of the coal seams and partly to the fact that the mines are not fully mechanized. Labor is also to some extent itinerant, so that various skills are not as far developed as in countries with a more constant labor force. When the development and mechanization that have been underway since 1948 are fully realized, improvement in productivity may be expected.

The average daily wage has gradually increased from TL 1.65 in 1941 to TL 6.95 in 1953. The continuous increase in wages per salable ton of coal shown in table 10 is due to the fact that daily wage and productivity have not increased at the same rate. Actually all of the increase in wages does not represent gain in purchasing power because of increase in price levels.

TABLE 10. - Coal production per man-shift, manpower, and wages, Turkey, 1941-54 and 1956

Source: Statistics of Eti Bank Mining Exploitations 1941-52 and Bulletin of the Mineral Research Institute of Turkey, Foreign Edition, 1954-55.

Year	Face workers	Underground workers	Underground and surface	Average number of workers per day	Average wage	Total wage per ton of salable coal
	Kilograms per man-shift				Turkish liras	
1941	2,344	721	626	21,738	1.65	5.56
1942	2,744	718	618	21,793	2.15	8.61
1943	2,765	668	576	26,814	2.89	11.69
1944	2,832	696	608	29,242	3.22	12.37
1945	2,775	698	605	29,605	3.49	13.83
1946	2,861	745	636	28,183	3.69 ($1.32)	13.96 ($4.98)
1947	2,875	748	647	28,209	4.37 ($1.56)	16.06 ($5.73)
1948	2,871	787	688	27,215	4.54 ($1.62)	15.42 ($5.50)
1949	2,881	822	726	27,626	4.68 ($1.67)	16.40 ($5.86)
1950	2,965	856	756	27,061	4.85 ($1.73)	15.38 ($5.49)
1951	3,160	933	823	26,389	5.15 ($1.84)	15.24 ($5.44)
1952	3,036	976	880	28,648	5.94 ($2.12)	17.91 ($6.39)
1953	3,154	1,012	916 1/	31,089	6.95 ($2.48)	18.90 ($6.75)
1954	3,160	978	886 1/	(2)	(2)	(2)
1956	3,438	995	887	(2)	(2)	(2)

1/ For 11 months.
2/ Data not available.

The selling price of coal at Zonguldak in 1956 was about TL 34.57 ($12.35) per ton; prices in other cities vary according to the transportation cost. For instance, the 1954 price of coal in Adana was $23.57 per ton. In 1952 the transportation cost of coal to Izmir, Ankara, Sivas and Malatya was, respectively, $3.10, $3.38, $6.60,

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and $6.68. The selling price of coal at the mine is established by the Government. In the past the mines have often shown an operational loss, because the selling price has been kept down by the Government to lower living costs.

Expansion Program and ECA Aid to Ereğli-Zonguldak Field

At the time of nationalization of this coalfield in 1940 the mines were not in a condition to sustain, on a long-term basis, an increased production; and without development most of the more easily accessible coal would have been mined out in a relatively few years. The Government prepared a development program, but progress was interrupted by World War II. Immediately after the war the development plan was revised with the help and advice of several American consulting firms. Actual start on the project was made possible in 1949 with ECA aid. By the end of 1955 its execution had cost the equivalent of $124,000,000. During the same period United States aid to the project through various aid agencies amounted to $45,000,000, of which nearly $20,000,000 was direct aid and the remainder was financed through European Payments Union. United States assistance to development of the Zonguldak basin ended with fiscal year 1956 funding. The program will cost perhaps the equivalent of $144,000,000 before it is entirely completed. The essential components are as follows:

1. Improvement of operations by combining existing mines.

2. Mechanization and electrification of Gelik, Kozlu, and Çaydamar mines, providing such facilities as underground haulage equipment, coal conveyors, portable compressors, ventilating fans, and pumps.

3. Construction of two central coal-washing plants in Zonguldak and Çatalağzi to replace the small washeries.

4. Connection of Kandilli mine by aerial tramway to Armutcuk, which will become a railroad station.

5. Surface development work at the Kozlu colliery including installation of winding equipment in two shafts, compressors, fans, transformer substation, etc.

6. Driving of some 17-km. rock galleries in the Kozlu mines.

7. Karadon mine development, consisting of installation of hoisting equipment, pumps, and compressors and driving 8.5 km. of rock galleries.

8. Construction of transfer stations, consisting of rotary dumps and belt conveyors. Karadon station conveys coal directly to Çatalağzi washery, and Asma station delivers coal to a loading point on the railroad for transportation to Zonguldak colliery. Asma transfer station has a normal capacity of 7,500 tons of run-of-mine coal and 1,120 tons of rock in 2 shifts.

9. Development of Armutcuk mine, including rock galleries, hoisting installations, pumping and compressed-air plants, and power distribution. A new coal-preparation plant of 200 tons per hour and a 150-ton-per-hour aerial tramway 1,800 meters long are also parts of this mine development.

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10. Construction of breakwaters at the port of Zonguldak to make possible, in all kinds of weather, the loading of ships not exceeding 10,000 tons directly from coal docks and to increase the loading capacity of the port.

11. Equipping Zonguldak Harbor with loading and storage facilities.

12. Establishment of standard-gage railroad connection between Kozlu, Asma and Caydamar mines and the port of Zonguldak and washery at Zonguldak, and acquisition of railroad equipment necessary to the operation of the lines.

Projects completed include Kozlu shafts and minus-300-meter-level development, Karadon shaft, Asma and Karadon transfer stations, Karadon-Armutcuk aerial tramway, Kozlu powerplant and fan installations, Çatalağzi washery, and harbor work at Zonguldak. The washery in Zonguldak, Armutcuk shaft, and Zonguldak railway connections and bridges are other projects completed or to be completed. Çatalağzi and Armutcuk shafts were to be completed in 1957. Development of the port of Zonguldak has particular significance. Because of the mountainous terrain of the area, a considerable amount of coal is shipped to Istanbul and other consuming centers by boat. Breakwaters, coal, pit-prop, and general-cargo wharves have been provided, and two 10,000-ton ships can be loaded simultaneously. Some views of the installations mentioned above are shown in figures 8-13.

Coal Washeries

In 1956, 5,453,220 metric tons of coal was washed, and 3,717,700 tons of prepared coal resulted. Coal washeries in the Zonguldak Basin were distributed as follows, with the output in tons per hour: Kandilli, 50; Kozlu (2), 100 to 120; Zonguldak, 90; Üzülmez-Asma, 60; Gelik, 100; Karadon, 50; Kilimli (2), 70 tons per hour. The majority of these have been replaced by 2 new washeries at Çatalağzi and the other at Zonguldak. The Zonguldak coal-preparation plant has a capacity of 750 t.p.h. in 3 parallel circuits and is located at Zonguldak. Briefly, the minus-100-mm. raw coal is passed through a Baum-type washbox the end products of which are washed coal, middling, and refuse. Middling is crushed to minus-6-mm. The 0.5-mm. x 0-mm. material from the crushed middlings is cleaned by a 120-t.p.h. flotation section and the 6-mm. x 0.5-mm. in jigs. Middling from the jigs is recleaned. The washery includes a 2,200-meter belt conveyor for refuse disposal and pump system for sludge disposal. The Çatalağzi washery is similar to Zonguldak but with 2 parallel circuits of 250 t.p.h. (tons per hour) each and a flotation section of 80 t.p.h. capacity. A 1,000-meter belt-conveyor system disposes refuse. A railway section is under construction between the Zonguldak railraod station and the Zonguldak washery. The narrow-gage railroad between Kozlu and the Zonguldak washery will be changed to standard gage. Coal from the five principal mines (Kozlu, Çaydamar, Asma, Gelik, and Karadon) will reach the washeries in the following manner:

To Zonguldak washery:

From Kozlu	By standard-gage railroad.
From Çaydamar	Do.
From Asma	Coal to a transfer station and then by standard-gage railroad.

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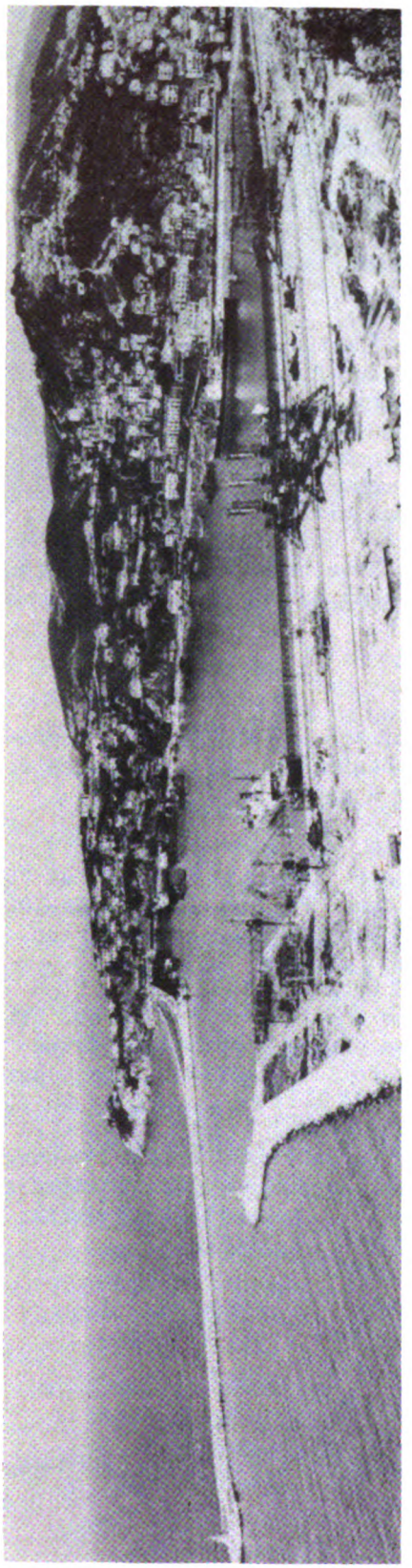

FIGURE 8. - Panoramic View of Zonguldak, Showing New Harbor, Ship-Loading Docks and Storage Areas.

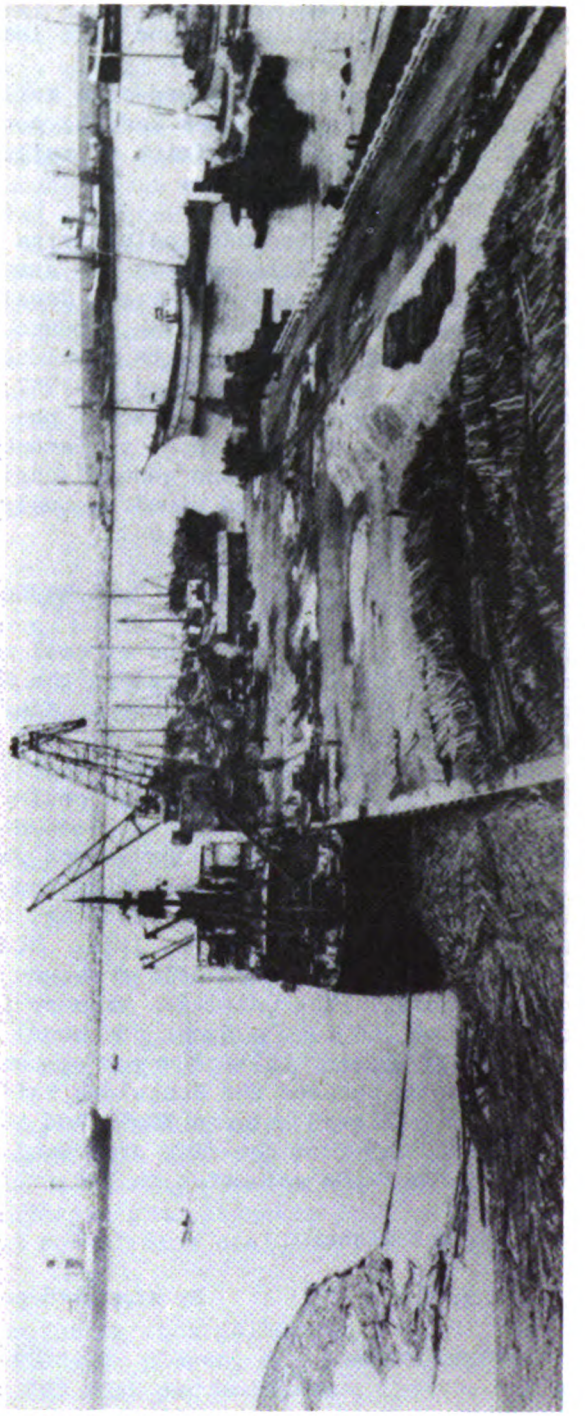

FIGURE 9. - Cargo Cranes in Zonguldak Harbor.

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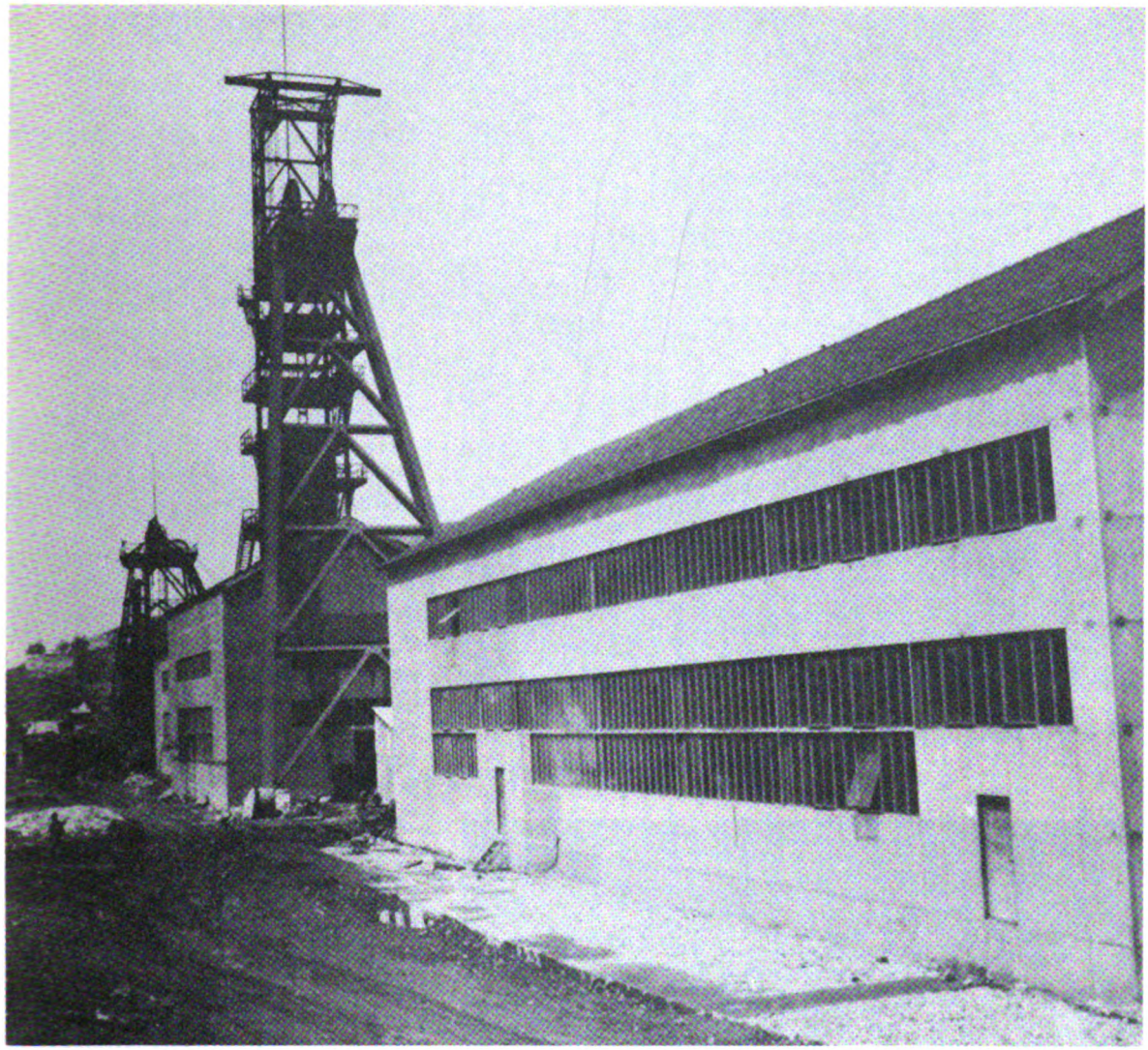

FIGURE 10. - Kozlu Hoisting Installations, Showing Hoisting Engine, Generator Building, and Headframe.

To Çatalağzi washery:

From Gelik	Coal will be hauled by 5-ton trolley locomotives to the Karadon transfer station. A belt conveyor from here delivers the coal to the top of the Çatalağzi washery.
From Karadon	Coal to belt conveyor and then to washery.

In the Ereğli group coal will continue to be washed in the existing plant at Kandilli. When the colliery at Armutcuk is developed, a new washery (200 t.p.h.) will be erected alongside, for preparing coal from Kandilli and Armutcuk mines. Zonguldak washery will ship, periodically, coal to Kozlu for the boilerhouse and coal to Asma for the coking plant.

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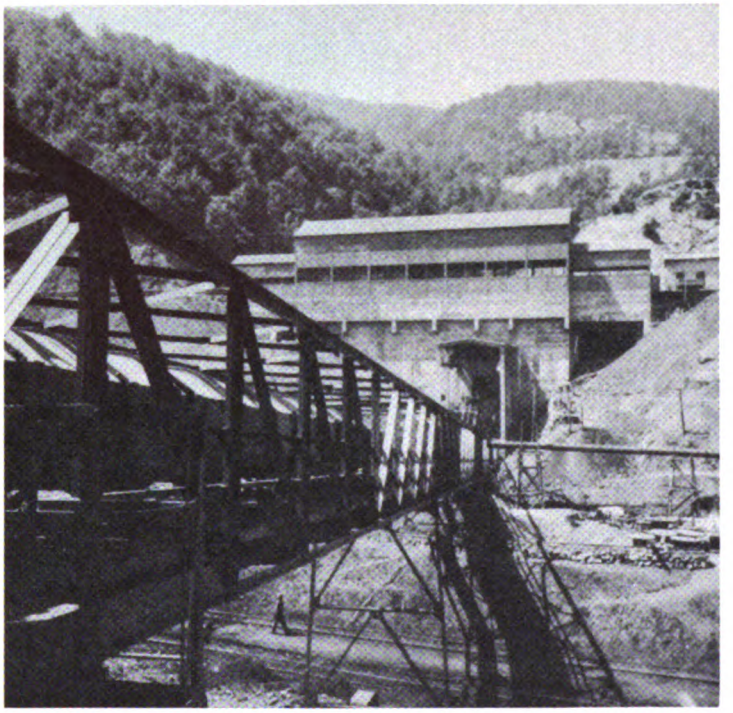

FIGURE 11. - Karadon Transfer Station and Transport Belt Conveyor.

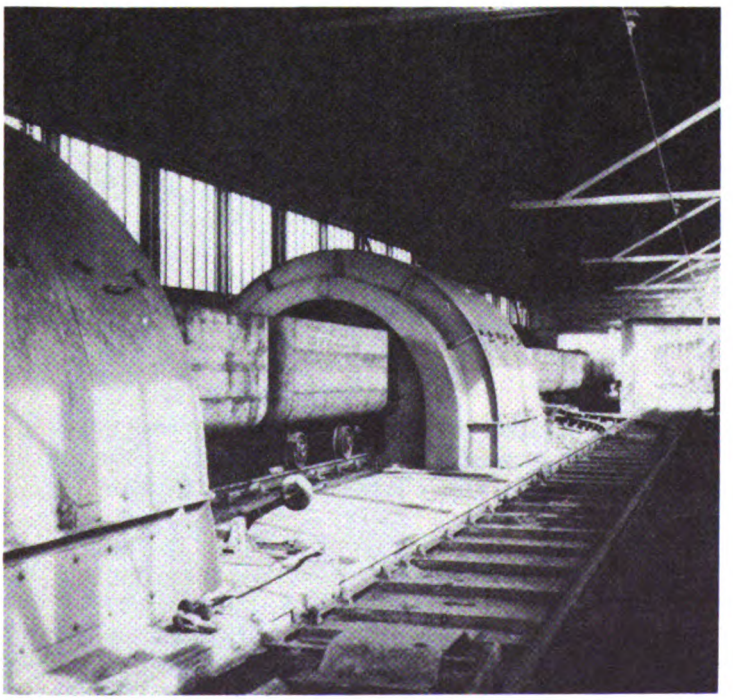

FIGURE 12. - Inside of Karadon Transfer Station, Showing Mine Cars and Rotary Dumps.

Powerplants

For many years the Zonguldak mines had been short of power, depending entirely on the plant at Kozlu, with a capacity of 10,000 kw. A new coal-fired powerplant with 3 units of 20,000 kw. each was completed in November 1948 at Çatalağzi. The capacity of this plant is now being doubled to 120,000 kw. Power from Çatalağzi will be more than enough to take care of the requirements under the electromechanization program.

Lignite

Consumer resistance resulting from prejudice against lignite and inadequate knowledge of its effective use have deterred exploitation of lignite deposits until recently. However, realization is increasing that this fuel, particularly in eastern Turkey, must be utilized if distribution of cheaper energy is to be obtained and that more of the valuable Zonguldak coal should be saved for metallurgical coke, for use in specialized installations, and for possible export. The cost of transporting Zonguldak coal to many parts of the country is more than the savings resulting from the greater heat value of the coal as compared with lignite. Despite the wide distribution of lignite in the east, the largest reserves are in western Turkey (see table 11).

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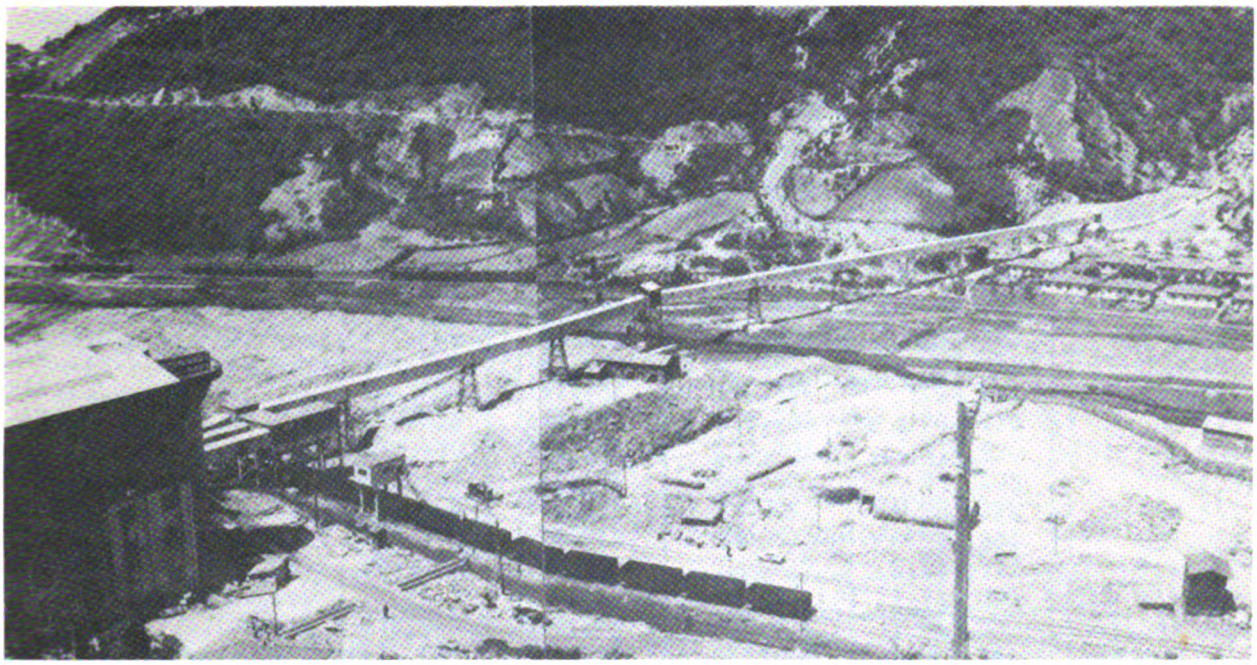

FIGURE 13. - View of Catalağzi Washery and Refuse-Disposal Belt Conveyor.

Lignite Mines in Western Turkey

Production of lignite (see table 2) has increased steadily in the last decade or so, with the 1956 output nearly seven times the 1941 figure. Of the total 1956 production of 3,010,000 tons, 2,070,937 had come from Soma, Tunçbilek, and Değirmisaz mines, operated by a subsidiary of the Eti Bank called Garp Linyitleri Isletmesi; 706,521 tons had come from private mines and the remainder from mines of Turkish railways and other state enterprises. The output of Garp Linyitleri Işletmesi mines in 1941-56 is shown in table 12. The geological conditions in these mines favor low-cost production, and the mines have easy access to road and rail transportation. The lignite is of good quality and has a high calorific value. In 1956 productivity figure for all 3 mines indicate 5,997 kilograms per miner shift and 1,915 kilograms for all employees.

As in the case of Zonguldak, ECA-FOA funds (amounting to nearly $7,500,000 direct aid) have been important in developing the mines mentioned. The funds were spent for providing electromechanical haulage equipment and additional power facilities at Soma, Tunçbilek and Değirmisaz.

Soma

General Information (1953). - The Soma mine (Mansia I1) is at the top of a steep hill at an altitude of 760 meters (2,500 feet). A very steep road from the town and railroad station of Soma climbs 700 meters along the Bakir Çay Valley to the mining camp. This field produced lignite as long ago as World War I and was taken over by the Eti Bank in 1940. ECA aid to the Soma mine involved installing surface and underground track and trolley facilities, conveyor systems, shaft and tunnel work, miscellaneous structures and buildings, and a new powerplant and boilers.

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TABLE 11. - Principal lignite deposits of Turkey

Source: 37 and others.

Province	Number of deposits	Principal deposits: Name and location	Principal deposits: Reserves 1/ (metric tons)	Calorific value (cal. per kg.)	Remarks
Western Turkey:					
Edirne	66	Karayusuflu, Meriç County	700,000	3,129	In 1955, 34,055 tons was produced from 31 properties.
		Serem, Meriç County	2,000,000	3,390	
		Kürttepe, Üzünköprü County	1,250,000	4,218	
		Harmanli, Üzünköprü County	1,435,000		
		Çavuşlu, Üzünköprü County	500,000		
		Maksutlu, Üzünköprü County	1,200,000	3,950	
Tekirdağ	65	Deposits in Saray County	38,000,000	4,000 to 4,557	In 1955, 24,955 tons was produced from 28 properties.
		Ahmet Paşa, Malkara County	1,000,000		
		Haliç, Malkara County	1,500,000		
		Kirikali, Malkara County	600,000		
		Malkara, Malkara County	855,000		
		Hafitköy, Malkara County	620,000		
		Kaliviya, Malkara County	600,000		
		Iğrekdere, Malkara County	-		
Istanbul	19	Ağaçli, Eyup County	10,000,000	2,764	1955 production, 12,820 tons from 6 properties.
		Kiracköy, Çatalca County	600,000		
Çanakkale	32	7 deposits in Çan County			In 1955, 76,889 tons was produced from 10 properties.
		Plaka Kuzu, Imroz Island	500,000		
Bilecik	18	Küre, Söğut County	Small		In 1955, output of Küre deposit was 2,441 metric tons.
Manisa	12	Soma, Soma County	22,000,000	4,900-5,200	In 1955, 4 mines produced 821,627 metric tons.
		Eyniş, Evciler, Türkpiyale and Deniş, Soma County	12,000,000	5,710	
Kütahya	23	Seyitömer, Kutahya County	89,000,000	2,800	In 1955, Eti Bank mines at Değirmisaz and Tunçbilek had an output of 1,130,506 tons and 11 private producers produced 50,294 tons.
		Değirmisaz, Emet County	6,000,000	5,900	
		Tunçbilek, Tavşanli County	65,000,000	3,300-5,300	
Aydin	21	Söke-Kuşadasi, Söke County	15,000,000		In 1955, 40,614 tons was produced from 7 deposits.
		Şahnali, Aydin County	1,750,000		
		Başçayir, Aydin County	500,000		
		Gerenez, Nazilli County	500,000	5,000	
Burdur	10	Akviran, Tefenni County	2,500,000		1955 production, 286 tons.
Central Turkey:					
Bolu	33	Merkeşler	24,000,000	4,500	1955 production, 9,240 tons from 3 mines.
		Salipazari	1,500,000		
Çorum	22	Dodurga, Osmancik County	16,000,000		1955 production, 356 tons.
Eastern Turkey:					
Amasya	10	Çeltek, Merzifon County	2,000,000	6,266	1955 production, 84,598 tons entirely from Çeltek.
Erzurum	26	Balkaya, Örtülü County	1,100,000	5,500-6,000	1955 production 30,117 tons from 2 mines.
		Aliçikrek, Hasankale County	2,000,000		
		Aziacik, Erzurum County	500,000	5,134	
		Kükürtlü, Aşkale County	1,500,000	5,900	
Sivas	63	Gemerek mines near Yeniköy, Karagöl and Çubuk Ciftlik, Sarkişla County.		4,000	In 1955, Gemerek mine produced 1,761 tons and another mine 123 tons.
Van	6	Şahanis, Gürpinar County	2,000,000	2,500	

1/ Measured, indicated, and inferred.

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TABLE 12. - Production of run-of-mine and marketable lignite, western lignite mines, Turkey, 1941-56
(Metric tons)

Source: 40 and 59.

Year	Mines				Total marketable
	Soma	Tunçbilek	Değirmisaz	Run-of-mine	
1941.....	92,734	48,633	57,966	199,333	176,789
1942.....	112,915	87,494	95,953	296,362	266,190
1943.....	161,214	129,893	169,648	460,755	419,659
1944.....	208,780	234,041	152,642	595,463	531,814
1945.....	209,805	192,386	186,424	588,615	523,194
1946.....	156,675	157,482	194,666	508,823	459,389
1947.....	210,235	252,865	239,218	702,318	603,795
1948.....	237,480	309,045	282,405	828,930	680,039
1949.....	267,185	345,626	344,684	957,495	777,600
1950.....	266,500	393,495	320,231	980,226	746,553
1951.....	295,830	401,849	296,615	994,294	751,020
1952.....	395,830	392,950	292,717	1,081,497	764,653
1953.....	(1)	(1)	(1)	1,314,083	942,321
1954.....	620,945	571,143	464,844	1,656,932	1,085,225
1955.....	674,875	706,795	423,531	1,805,381	1,060,744
1956.....	665,250	945,810	459,877	2,070,937	1,316,685

1/ Not available.

The lignite bed is of Miocene age; it originally was perhaps saucer-shaped but has been much disturbed and faulted, with dips of 10° to 40°, with a marl or mudstone hanging wall and a clay foot wall. Three fields, in proximity to each other, have the following reserves (1953), in metric tons: Main field, 19,520,000; west of main field, 2,430,000; east of main field, 389,000.

The overburden varies from 40 to 150 meters; the thickness of the bed is 5 to 6 meters. The run-of-mine lignite has 28 percent ash, 18 percent moisture, and 60 percent fixed carbon after ash and moisture are deducted. The calorific value is 4,900 to 5,200 calories per kilogram, equivalent to 8,840 to 9,380 B.t.u. per pound.

Entry to the mine is by a 10-1/2° incline. The level at the entry is 760 meters (2,494 feet), and at the bottom of the incline it is 660 meters (2,165 feet). Slope length of the incline is about 600 meters (1,960 feet). A similar incline acts as ventilation upcast. The lignite is won by sublevel caving in 5-meter slices.

The mined lignite is loaded by conveyors into 5-ton steel cars, which are hauled to the bottom of the incline by d.c., 250-volt, 250-hp. Westinghouse locomotives. Here they are picked up and hoisted by an electric winding engine. At the surface the cars are hauled again by Westinghouse locomotives to the rotary tipples.

The run-of-mine lignite is sent down the valley to the washery by a 6,200-meter aerial ropeway, constructed by Paulig of Germany. The ropeway has an hourly capacity of 150 tons and is equipped with 600- and 1,000-kg. buckets; its speed is 3-1/2 meters per second.

Mine equipment consisted of 3 Ingersoll-Rand compressors, 7 Westinghouse locomotives, 52 Joy conveyors, and welded-steel mine cars. The mine has its own powerplant.

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The number of underground miners in 1953 was 430. The output per shift per underground miner was 3 tons, and for all labor, including the main services, 2 tons. Mining cost per ton of crude lignite was TL 6 to TL 7 ($2.14 to $2.50), and the price of 1 ton of washed lignite delivered in railroad cars is TL 16 to TL 17 ($5.71 to $6.07).

Washery. - The Soma washery (165 tons per hour capacity) was designed and constructed by McNally of Pittsburg, Kans. The flowsheet is schematically shown in figure 14. Two Baum-type jigs clean the 0- to 10-mm. and 18- to 100-mm. coal. The clean lignite goes to screens, where three sizes are separated. The fines go to a settling tank and are eventually recovered in a drier.

It was planned to use a good deal of the 10- to 18-mm. fraction for firing new boilers, in which case this part of the plant will not operate regularly.

Powerplant. - The powerplant is next to the washery, near the Soma railroad station. Of four 1,000-kw., steam-driven generators, 2 are driven by Worthington steam turbines (4,528 r.p.m.), which have been in operation since 1948. Purchase of this powerplant and the washery was financed by a loan from the Export-Import Bank.

The new additions are 2 units, each consisting of an AEG turbine, 6,300-r.p.m., driving a 1,250-kw. AEG generator running at 1,500 r.p.m. Generated voltage is 3,300 and current 218 to 230 amperes. The powerplant has excess power to sell to a nearby town.

The old part of the powerplant has three Combustion Engineering package-unit boilers. Each raises 12,000 pounds of steam per hour at a pressure of 450 pounds and 750° F. temperature. Ash is removed by hand. The new turbines receive steam from 2 Durr boilers, each with a steam capacity of 8 tons per hour, delivered at a pressure of 32 kg. per cm^2. at 450° C. The boilers are equipped with Steinmüller coal feeders. The coal takes one half hour to travel through the grate box with this type of feeder. Ash drops to a hopper below and is removed by car.

Tunçbilek

The Tunçbilek mine (Kütahya Il) is 14 km. (9 miles) north of Tavşanli. Reserves are estimated at 65,000,000 tons. The equipment (consisting of trucks, conveyor belt, shop, and auxiliary facilities) was purchased for the mine with ECA funds in 1950. A 2,000-kw. powerplant, financed by a loan from the Export-Import Bank, was completed in 1950 and later expanded to 4,000 kw. with ECA funds. The expansion was completed in 1953. Simultaneously, a washery of German manufacture (4,000 tons per day) was installed.

Değirmisaz

Değirmisaz mine (37 km. west of Tavşanli in Kütahya Il) has a reserve of 6,000,000 tons, which exploration is expected to increase further. Miscellaneous surface and underground equipment, including conveyors, pumps, and jackhammers, was provided under the ECA program. Installation of a new jig-type washery (1,500 tons a day capacity) and a powerline 38 km. long from this mine to Tunçbilek were completed in 1953. The mine receives power from Tunçbilek, where excess capacity is available.

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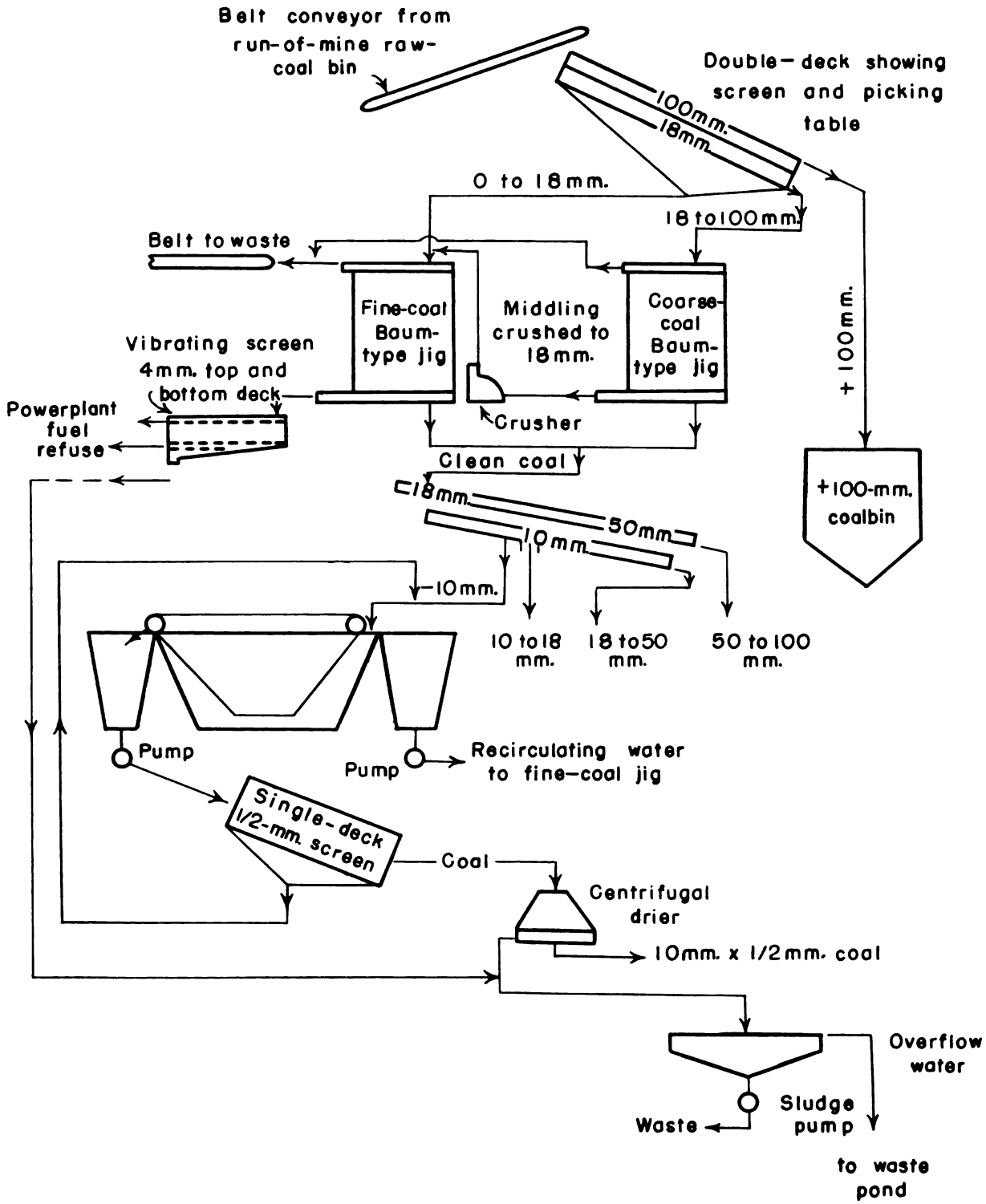

FIGURE 14. - Washing-Plant Flowsheet of Soma Lignite Mine.

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Agaçli

The Agaçli field (25 km. from Istanbul) was opened in June 1949 and produced about 13,000 tons of lignite in that year. The mine was operated by a subcontractor to the Eti Bank, but early in 1950 the contract was terminated by the latter, and production has been small. Indicated and inferred reserves are estimated at 10,000,000.

Other Mines in Western Turkey

In addition to the above-mentioned 4 mines, about a dozen or so private lignite operators produced 133,000, 185,000, 326,500, and 433,551 metric tons of run-of-mine lignite in 1951, 1952, 1953, and 1954. These mines include: Cumaovasi, Tire, and Kinik near Izmir and mines in Kütahya and Burdur Ils.

Lignite Mines in Eastern Turkey

Attention has recently been focused on the great advantage of meeting, as far as possible, the commercial and domestic demands for fuels in eastern Turkey from local deposits, in order to diminish the use of wood and manure for fuel. Wood is either scarce or nonexistent in many eastern Provinces. Widespread use of lignite would depend on availability of the fuel at a reasonable price and roads from mines to consuming centers. Equally important is whether or not lignite-burning stoves can be manufactured domestically and cheaply.

Numerous (reportedly 272) lignite deposits occur in Turkey's eastern Provinces, some of which are shown in table 11. Reserve estimates for many deposits are not available; geological investigation and field exploration are required to determine if they are of economic value. Although the known reserves are small, exploratory work is expected to increase the tonnages.

Actual mining is carried out only in a few localities, of which the most important is Çeltek. Other mines are Balkaya, Kükürtlü and Gemerek described in table 13.

Petroleum

Domestic production of petroleum and the refining of petroleum products are not yet important compared with consumption, which has increased rapidly as a result of increased mechanization of agriculture, industrialization, and expansion of mechanized transportation. Requirement trend over the next several years is expected to continue upward, but actual consumption will be limited by the availability of foreign exchange.

In 1956 imports of petroleum products amounted to 802,705 metric tons compared with 234,000 tons of domestic production (excluding 41,700 tons of asphalt). Imports (table 14) are normally supplied by United States and British marketing companies. A large percentage comes from sources of supply in the Persian Gulf, although imports from the United States increased while the Abadan refinery was closed. With resumption of operations at this refinery and completion of additional refinery capacity in the Persian Gulf area, the Middle East oilfields regained their predominant position as sources of supply for Turkey.

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TABLE 13. - Lignite mines in eastern Turkey

Province: Name and location	Description
Amasya: Celtek; 45 miles SW. of Samsun.	Reserves: Measured, 7,000,000 tons. Mining: Mine operated by Turkish State Railway.
Erzurum: Balkaya; 160 kilometers NE. of Erzurum.	Reserves: Inferred, 10,000,000 tons. Geology: 3 seams, varying in thickness from 2-1/2 to 5 meters, and dipping from 15° to 45° NW. Continuation of these seams has been seen at a point 2-1/2 km. NE. of main workings, and lignite outcrops have reportedly been traced for 6 km. in a general direction of N. 72° E. Ownership: Balkaya Maden Kömürleri Ltd., Sirketz, Erzurum, Turkey. Mining: Mine is developed by adits. Coal is won with pick and shovel and screened at adit portal. Lignite seems to be of good quality but contains pyrite veinlets. Calorific value, 5,500 to 6,000 calories. Transportation: It is understood that provision has been made to construct a new 80-km. road from Kosar to Yenikoy railroad station on the Kars-Erzurum Railway.
Kükürtlü: 15 km. S. of Askale village; itself 57 km. W. of Erzurum.	Reserves: Inferred, 500,000 tons. Geology: There are 3 seams, varying in thickness 0.9 to 1.1 meters; 2 dip on a 30° angle and 1 vertically. Mining: Coal is won in 2 rooms. Lignite is used in Erzurum for heating and some power production. 1954 production, 1,822 tons. Mining company: Formerly operated by the Eti Bank and now worked by Şark Linyitleri, Ltd., Şirketi.
Sivas: Gemerek group; 110 km. SW. of Sivas and 41 km. SW. of Şarkişla.	Reserves: Indicated, 130,000 tons; inferred, 500,000 tons. Total may be much more than above figures indicate. Mining: There are 2 adits on strike and 1 on a slight upgrade. Lignite seam is 0.70 to 1.1 meters thick, and about same thickness of footwall shale is mined out in the adits.

The cost of imported petroleum products constitutes a drain on Turkey's foreign exchange, representing 7.2 percent of total imports in 1952 and 8.6 percent in 1952-56. An important factor in creating the new liberal oil policy, whereby private capital, domestic as well as foreign, is allowed to participate in developing the country's petroleum resources, was the desire to reduce Turkey's dependence on foreign imports and so strengthen its international balance of payments.

Present known exploitable reserves of petroleum have been estimated as 10,000,000 metric tons. These known reserves are small compared with annual consumption and

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occur in an area far removed from centers of consumption. However, the estimate of reserves may be low. Further prospects for discovering substantial volumes of oil in existing operating oilfields and other areas is considered favorable. Already much useful exploratory work has been done, and two pools have been discovered. The presence of several large oil companies in the field in Turkey, and the newly approved petroleum law, augur well for active exploration and drilling by private capital.

Production

Crude-oil production began with the discovery of oil in the Ramandağ field in April 1940; however, the output was small during World War II and the years immediately following. Reported production figures since 1946 follow:

Production of crude petroleum, 1946-57
(Metric tons)1/

1946.....	445	1950.....	17,037	1954.....	59,008
1947.....	526	1951.....	19,064	1955.....	178,536
1948.....	2,854	1952.....	21,697	1956.....	286,000
1949.....	11,510	1953.....	26,545	1957.....	298,139

1/ 6.879 barrels per metric ton.

Refining

The entire output is refined at Batman and consumed in Turkey. Batman is a railroad station on the Diyarbakir-Kurtalan railroad, 90 km. east of Diyarbakir. Before operation of the refinery, some of the crude was delivered to a small topping plant and some to the State railroad. In January 1953 a contract was awarded to Ralph M. Parsons Co. to construct a refinery at Batman with a daily capacity of 6,950 barrels and an estimated annual production of gasoline of 53,000 metric tons; kerosine, 25,000; diesel oil, 10,000; fuel oil, 130,000; cutback road oil, 37,000; and asphalt, 75,000. The refinery began production in 1955, and output since then has been as follows in metric tons:

	1955	1956	1957
Gasoline.....	3,945	52,153	62,666
Diesel oil.....	7,686	17,870	15,630
Fuel oil.....	55,417	165,896	157,416
Asphalt.....	16,366	39,255	36,225
Solvent.....	-	-	407

The fuel oil is used by the railroads in eastern Turkey, and other products are supplied to the local market, except for asphalt, which may be distributed in the rest of the country. A 3-inch, 22.5-km. pipeline transports crude from Ramandağ to the refinery site; the Garzan crude pipeline joins that from Ramandağ southeast of Batman.

Facilities at the refinery include a 6,250-kw. powerplant, 51 storage tanks with a total capacity of 70,000 cubic meters, loading and filling facilities for cans, barrels, trucks, and railway cars, and a canmaking factory.

Four companies, Mobil Overseas Oil Co., California Texas Corp., The British Petroleum Co., and Royal Dutch Shell, have reached agreement with the Turkish Government to construct a 65,000-barrel-per-day refinery at a location to be decided. Gasoline, kerosine, diesel oil, and heavy fuel oil will be produced. In addition in the

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second quarter of 1956 the Council of Ministers authorized William Blair of Chicago to build a $10,000,000 refinery near Adana or Mersin.

Imports

Nearly four-fifths of Turkey's liquid-fuel requirements are met by imports. Imports for 1950-56, table 14, shows a rapid rise to a maximum of 969,034 metric tons in 1955, nearly twice the 1950 tonnage. Reduced imports in 1956 resulted from shortage of foreign exchange rather than lower requirements. In 1956 about 91 percent of the imports consisted of gasoline, kerosine, and diesel oil, and the remaining 9 percent comprised fuel oil, lubricants, asphalt, tar, etc.; Turkey does not import crude. A large portion of the imports comes from sources of supply in the Middle East. The cost of petroleum imports in 1953, 1954, 1955, and 1956 has been TL 124,629,218, TL 115,195,325, TL 118,194,455 and TL 99,700,000 respectively, or about $41,000,000 to $45,000,000.

Gasoline, kerosine, fuel oil, and diesel oil are brought in by tankers. Turkey has ocean terminals with a capacity of about 190,000 metric tons or about 1,500,000 U. S. barrels. The terminals, near Istanbul, Izmir, and Iskenderun, can accommodate modern tankers. A share of the white products are brought to Turkey aboard Turkish tankers.

Consumption

Consumption data are not available; however, for the purpose of this report, apparent consumption of petroleum products approximately equals imports plus domestic production. On this basis, 1956 consumption was 1,078,338 metric tons (nearly 24,000 barrels per day), divided as follows:

	Production	Imports	Total
Gasoline.....	52,153	225,671	277,824
Diesel oil.....	17,870	300,742	318,612
Fuel oil.....	165,896	27,470	193,366
Kerosine.....	-	204,840	204,840
Lubricants.....	-	43,982	43,982
Asphalt and tars.....	39,255	459	39,714

The 1956 apparent consumption was nearly twice that for 1950 and reportedly 7 times that for 1939. The rapid increase in petroleum-driven equipment has been the most important factor contributing to the increased consumption. Motor-vehicle registration (excluding military vehicles) for several selected years is shown in the accompanying table:

Motor-vehicle registrations

	1938	1945	1948	1950	1953	1955
Cars.....	4,600	3,400	4,600	10,000	23,938	28,600
Trucks....	3,900	4,500	10,100	13,200	24,722	30,300
Buses.....	1,044	988	300	3,185	5,510	9,500
Total	9,544	8,888	15,000	26,385	54,170	68,400

The number of tractors increased from 1,200 in 1946 to 10,000 in 1950 and 40,000 in 1956. Civil air transport in Turkey has also increased to some extent during the last few years. Diesel and oil-burning locomotives in operation in 1955 numbered about 100. The rising trend in consumption probably will continue for the next few years but not at the same rapid rate as since 1950.

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TABLE 14. - Imports into Turkey of petroleum products, by countries of origin, 1950-56 (Metric tons)

	Gasoline	Kerosine	Fuel oil	Diesel oil	Lubricants	Asphalt	Tars, etc.	Total
1950								
Bahrein.....	44,333	16,374	32,858	27,417	-	-	-	120,982
Iran.....	52,486	36,599	2,011	27,844	-	2,026	-	120,966
Saudi Arabia..	73,064	65,153	13,049	46,688	-	-	-	197,954
United States.	25,374	6,801	-	2,833	21,774	138	-	56,920
Others.....	401	2	55	-	2,815	440	-	3,714
Total....	195,658	124,929	47,973	104,782	24,589	2,604	-	500,536
1951								
Bahrein.....	12,291	10,548	48,351	19,342	-	-	-	90,532
Iran.....	49,131	39,936	595	25,503	-	3,217	-	118,382
Saudi Arabia..	148,222	93,270	617	93,120	-	-	-	335,229
United States.	24,388	14,348	-	-	31,948	1,689	-	72,373
Others.....	11,064	12,914	-	13,269	3,518	2,934	-	43,699
Total....	245,096	171,016	49,563	151,234	35,466	7,840	-	660,215
1952								
Bahrein.....	56,534	25,255	45,421	47,521	-	-	-	174,730
France.....	11,239	9,909	-	9,822	9	5	-	30,983
Saudi Arabia..	158,173	120,319	14,251	137,374	-	-	-	430,117
United States.	22,760	12,065	-	5,395	41,590	2,506	294	84,610
Others.....	31,972	34,976	1	18,820	3,587	7,318	292	96,968
Total....	280,678	202,524	59,673	218,932	45,186	9,829	586	817,408
1953								
Bahrein.....	50,768	18,604	2,573	36,621	-	-	-	108,566
Saudi Arabia..	145,518	98,438	30,839	156,655	1,545	-	-	432,995
United Kingdom	38,657	31,755	218	35,755	8,422	74	777	115,658
United States.	85,749	68,965	-	67,304	43,530	1,366	654	267,568
Others.....	8,700	10,347	131	6,150	4,878	4,541	175	34,920
Total....	329,392	228,107	33,761	302,485	58,375	5,981	1,606	959,707
1954								
Bahrein.....	47,783	19,046	8,183	39,756	-	-	-	114,768
Iraq.....	8,683	13,005	100	6,551	-	-	-	28,339
Saudi Arabia..	104,729	73,423	19,347	147,710	130	-	-	345,339
United Kingdom	32,976	39,589	-	33,191	6,205	1,400	457	113,818
United States.	96,339	81,052	609	87,726	39,504	2,500	191	307,921
U.S.S.R.	7,738	2,670	-	-	-	-	-	10,408
Others.....	5,147	10,686	-	5,151	6,342	12,750	298	40,374
Total....	303,395	239,471	28,239	320,085	52,181	16,650	946	960,967
1955								
Bahrein.....	17,249	12,689	859	15,209	-	-	-	46,006
Iraq.....	4,457	8,115	-	5,197	-	-	-	17,769
Saudi Arabia..	122,233	81,418	23,781	175,175	1,314	-	-	403,921
United Kingdom	50,530	47,843	100	43,240	7,960	3,470	1,386	154,529
United States.	96,414	78,864	-	106,131	30,748	1,237	917	314,314
Others.....	1,845	4,358	10	9,342	11,583	5,216	141	32,495
Total....	292,728	233,290	24,750	354,294	51,605	9,923	2,444	969,034
1956								
Bahrein.....	13,660	23,926	6,676	44,290	-	-	-	88,552
Iran.....	2,500	6,676	-	10,049	-	-	-	19,225
Italy.....	20,339	5,517	-	11,746	-	-	1	37,603
Saudi Arabia..	57,505	54,628	20,089	99,500	72	-	-	231,794
United Kingdom	56,697	57,582	-	62,497	7,614	403	29	184,822
United States.	74,666	55,452	703	72,196	31,454	-	-	234,471
Others.....	304	1,059	2	464	4,842	11	15	6,697
Total....	225,671	204,840	27,470	300,742	43,982	414	45	803,164

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Although information on the consumption pattern is not available, the import data indicate that road transportation (gasoline), power generation (diesel oil), and domestic illumination, heating, and cooking (kerosine, also used in tractors) were the most important uses. Largest consuming centers are in and around Istanbul, Ankara, Izmir, and Iskenderun.

Storage, Distribution, and Marketing

From the various port terminals petroleum products are transported to relay points as bulk by tank cars, tank trucks, and motor vessels or in drums and cans packaged at the terminals. In 1951, 500 distributing points were operating throughout the country. In remote areas, where storage and distribution facilities are not yet developed, petroleum products are delivered and distributed in 5-gallon cans. It is estimated that, for 1951, distribution in such types of packages amounted to 30 percent of the total volume of refined products consumed - comprising 15 percent kerosine, 10 percent gasoline, and 5 percent gas oil.

In Istanbul and Ankara the marketing companies distribute the products through a system of service stations and pump outlets supplied from local relay depots. For other cities the companies generally have appointed official agents who effect retail sales. The agents are supplied directly from terminal installations or from relay depots. Large consumers, mostly Government departments and municipal electric powerplants, are generally supplied directly by the companies, who also usually furnish the necessary underground storage.

The lubricants are imported already blended or in bulk for local blending. The Mobil Oil Co. has constructed a new blending plant in Istanbul, with a reported capacity of 12,000 tons per year, and the Petrol Ofisi is also engaged in blending and packaging lubricants at Serviburnu near Istanbul. Probably 50 percent of the lubricant imports are in bulk for local blending.

The five marketing companies in Turkey are: (1) Mobil Oil Türk A.O.; (2) Petrol Ofisi Umum Müdürlügü; (3) Shell Co. of Turkey, Ltd.; (4) British Petroleum Aegean Ltd.; and (5) Türk Petrol ve Madeni Yağlar T.A.Ş. (incorporated in Turkey). The two largest distributors are the Mobil Oil and the Petrol Ofisi companies, which market 70 to 75 percent of the total. As their names imply, the next 2 companies are subsidiaries of Shell and British Petroleum and handle perhaps 25 percent of the market. Mobil Oil is the supplier to Türk Petrol ve Madeni Yağlar T.A.Ş., which sells oil retail. Petrol Ofisi obtains all its imports from California Texas Oil Co., Ltd. (Caltex), except that often it buys lubricants from other suppliers. Petrol Ofisi is the chief supplier of petroleum products to the Turkish Government, including the Armed Forces. It is represented by more than 300 agents and 800 service stations throughout the country and has about 184,000 cubic meters of storage capacity, roughly 48 percent of the nation's total.

The share of each of the five distributing agencies in imports is determined by foreign-exchange allocation made to each company by the Ministry of Economy and Commerce. The allocations are based upon estimates of petroleum requirements for any given year.

Prices of petroleum products, fixed by the Ministry of Economy and Commerce, include customs duty, municipal duty, consumption, transaction, road, and pier taxes, treasury share in profits, and storage fees. The c.i.f. costs, taxes, duties and prices of gasoline, kerosine, and fuel oil per metric ton in 1957 were as shown in the accompanying table. The selling price is nearly 5 times the c.i.f. cost for

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gasoline and 3.5 times that for kerosine. The above retail price is equivalent, at the official rate of exchange, to 72.8 cents per gallon compared with 62.2 cents in January 1954.

Costs of gasoline and kerosine per metric ton, in Turkish liras, 1957

	Gasoline	Kerosine	Fuel oil
C.i.f. cost	138.85	118.74	109.57
Total taxes and duties	495.69	195.44	222.70
Duty-paid cost	634.54	314.18	332.27
Losses, general expense, and other wholesale profit.	66.27	57.30	51.74
Wholesale price	700.81	371.48	384.01
Retail price	727.81	396.48	394.01

Government revenue from import and distribution of petroleum products is considerable. In 1951 the receipts, TL 96,249,000, equaled 7.16 percent of the country's revenue, exclusive of loans. Approved estimate for consumption tax on petroleum for Turkish fiscal year 1956 is TL 136,000,000.

Petroleum Exploration and Known Fields

In 1933, a year that marked the beginning of consistent Government effort to discover oil in the country, the Turkish Government created a service for exploration and exploitation of petroleum resources. When the Mineral Research and Exploration Institute (MTA) was established in 1935, the exploration service was incorporated in it. From 1935 until enactment of the new Petroleum Law on March 7, 1954, all exploration, drilling, and production were conducted by the MTA because it was Government policy not to allow foreign oil companies to participate in the development of Turkey's petroleum resources. During this period 87 wells were drilled of which 18 were shallow wells drilled for obtaining structural information. By March 1, 1956, with passage of the amendment to and the regulation under the 1954 Petroleum Law, 12 companies had applied for and received 155 exploration licenses, having done some reconnaissance work under special permit; subsequently 2 other companies joined in the exploration. Companies holding licenses and the number of licenses granted are shown in the accompanying table:

Companies granted licenses for petroleum exploration, March 1, 1956

Name of company	No. of licenses
Esso Standard (Turkey) Inc.	27
Royal Dutch Shell	21
Tidewater Oil Co.1/	22
D. D. Feldman Oil & Gas Co., Inc.1/	9
Mobil Exploration Mediterranean	24
Gilliland Oil Corp.1/	2
Bolsa Chica Oil Co.1/	5
Istanbul Tabii Gas Ltd., Şirketi	5
Husky Oil Co.1/	4
C. Deilman Montan G.m.b.H.	4
American Overseas Petroleum, Ltd. (owned by California Texas Oil Co.)	15
Türkiye Petrolleri A.O.	17
	155

1/ Independent oil company operating in United States.

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Installations and rights of the MTA are taken over by the Türkiye Petrolleri A.O. (Turkish Petroleum Corp.) set up in 1954 within the framework of the Petroleum Law. The Batman refinery is also to be controlled by this corporation, in which the Government has a majority share.

Ramandağ and Adjacent Fields

MTA has discovered 2 fields - Ramandağ, about 70 miles east of Diyarbakir and close to the Syrian frontier; and Garzan - 25 km. northeast (in a straight line) of Ramandağ. In addition, exploratory drilling has been carried out at Kentalan, 40 km. ENE. of Ramandağ, and in the Adana area, near the Gulf of Iskenderun. Between 1934 and 1939 three wells were drilled on the Basbirin, Hermis, and Kerbent structures between the Tigris River and the Syrian border, all within 25 to 30 miles of the town of Midyat near the Syrian border. None of these wells produced oil, although they had favorable indications. Raman No. 1, spudded in July 1939 on the Raman anticline, struck oil in April 1940 at a depth of 1,048 meters (3,458 ft.). When the well was deepened to 1,056 meters, water was struck, which increased in quantity and 6 months later made up 98 percent of the flow. This well was abandoned in 1944. Drilling to the north, west, south, and east gave only a small production in one well. Before the area was abandoned, well 8 was drilled about 4 to 5 km. to the east near the longitudinal axis of the structure. This well, bottomed at 1,364 meters (4,500 ft.), gave 4 to 5 tons of pure oil per day. Raman No. 8 may be considered the first successful producing well in Turkey.

Geology of Ramandağ Field. - The field (average altitude, 1,200 meters or 4,000 feet) is 22 km. south and a little east from the railroad station of Batman.

Southeastern Turkey, where the Ramandağ field is situated, is characterized by long anticlinal folds, the foredeep between the Arabian shield and the southern wing of the Alpine geosyncline. The border folds are a continuation of the Zagros Mountains, which, running northwest-southeast in Iran, take an east-west direction in Turkey. Under suitable conditions four horizons may be oil bearing:

1. Midyat limestone (Eocene), if under enough cover.

2. Cretaceous massive limestone, the production zone in present wells in Ramandağ.

3. Jurassic-Triassic series.

4. Permo-Carboniferous black massive limestone.

The possibility of finding oil in horizons lower than the Cretaceous massive limestone is suggested by the fact that seepages have been reported in various outcroppings of the series. Furthermore, the Devonian sandstone underlying the limestone series is, in many localities, saturated with oil, although the contention that this oil did not originate from stratigraphically higher strata is by no means certain.

The Ramandağ structure is an east-west anticline 56 km. long and 10 km. wide. The producing part of the anticline is 10 km. long; the width is variable and may be 400 to 1,000 meters. The north flank is very gentle, with a dip of 10°. The south flank is steep; its dip may increase to 90° and may even be overturned. The accompanying log of one of the wells may be considered typical of the sequence; the objective in all Raman wells is the Cretaceous massive limestone.

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Extracts from Ramandağ well log

Formation	Depth, meters	Local nomenclature	Remarks
Upper Eocene	250-300	Midyat limestone	Cavernous and difficult to drill because drilling mud is often lost.
Lower Eocene	500	Gercüs formation	Sandy marl and sandy shale. Intercalations of limestone in the upper part.
Paleocene	1,160	Upper Germav	Dark-gray, dense shale and gray marl.
Maestrichian	1,360	Lower Germav	Gray, marly shale and gray marl.
Do.	1,380	Orbitoid formation	Light-gray crystalline limestone, with abundant orbitoids in southern part of field.
		Unconformity	
Do.	1,420	Oil-bearing limestone	Very pure limestone, which is massive. In upper part it is permeable and oil bearing; deeper it is dense and compact.

On the flank of the anticline is a red and gray marl between the oil-bearing limestone and the orbitoid limestone, which in deep-flank wells may be as much as 70 meters thick. The oil-bearing zone of the reef limestone varies from 40 to 100 meters in thickness. Drilling experience has shown that wells on the crest of the anticline and those on the northern flank, which are not too close to the precipitate change of dip, are good producers. However, owing to the varying dip of the axial surface, there is horizontal displacement between the anticline axis of the Midyat at the surface and the axis of the oil-bearing formation.

In all, the field is considered to have 15 producing wells. Before the refinery was constructed, production per well was kept down to 300 to 350 barrels because of the small capacity of the Batman topping plant. The crude is heavy (API density, 20°) and carries 4 percent sulfur. Reservoir pressure is low, and the crude must be pumped.

Garzan Field

The Garzan anticline, discovered in 1950, is similar to the Ramandağ in structure, stratigraphy, and strike; however, according to F. Bender, the oil zones of Garzan and Kentalan (see below) are not the exact stratigraphic equivalent of the Raman producing zone. The Orbitoid limestone lies directly but unconformably over the massive limestone instead of the reef limestone. The Orbitoid limestone is considered to be the reservoir rock and is 15 meters thick.

The total number of producing wells in this field is 6, and the pool probably measures 4 kilometers by 300 meters. The Garzan crude is lighter (26° API) and has a sulfur content of 2.5 percent. With completion of a 22.5-km. (14-mile) crude-oil line from the Garzan field to Batman refinery, the field went into production in early 1957.

Kentalan

The most northerly structure investigated in the border foldings is Kentalan, which apparently is more complicated than the anticlines of Ramandağ and Garzan. Owing to erosion, 1,000 meters less drilling is required to reach the oil horizon, which

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is at a depth of 500 to 600 meters. Four wells have been drilled in Kentalan without striking oil. The reason suggested has been that erosion of the Paleocene and Maestrichian has left insufficient cover to prevent escape of crude from the reservoir rock.

Prospects of further discoveries in the region of border foldings are considered favorable. A reconnaissance survey of the area between Raman and the Syrian border has shown that many anticlines in the area, not yet mapped, offer good possibilities for oil pools. Another possibility is that oil may be found in a deeper or second horizon. Deep test wells 14 and 16 in Raman, which were sunk to examine this horizon, were not successfully completed. This deeper horizon may be a Devonian sandstone, in some places impregnated with asphalt and oil, and underlying the predominantly lime-dolomitic series of Cretaceous, Jurassic, Triassic, and Permo-Carboniferous series.

Adana Area

The Adana area occupies part of the geosynclinal area on the west side of the Arabian block. The basin has a great thickness of Miocene shale, with several seemingly favorable structures. Based on geological and geophysical work, a well was started in the Hocali structure in 1939 but had to be abandoned at a shallow depth because of heaving shale in the well. Further work was stopped during World War II but resumed in 1949. Other wells drilled since then comprise Hocali No. 2, abandoned in 1952 at 3,168 meters, still in Lower Eocene shale; Hocali No. 3, 7 km. northeast of Hocali No. 2, which encountered a strong gas flow at about 970 meters and was abandoned at 2,460 meters on account of rupture of the casing following an earthquake in the area; and Hocali No. 4, drilled to a depth of 3,541 meters in 1953-54. Although attempts to drill through the unusually thick Miocene beds have not yet been successful, the area is still believed to have promise.

Other Oil Prospects

Near the village of Çengen, about 15 km. south of Iskenderun, is an important oil seepage. In addition to structural wells the following production wells were drilled in the area by the MTA: Çengen No. 4, abandoned at 735 meters after encountering some oil, gas, and water; Çengen No. 5, abandoned at 714 as a dry hole.

In the coastal area of Thrace two areas, Mürefte and Hoşköy, have been drilled. At Mürefte about a dozen shallow (less than 350-meter) wells were drilled. All had some showing of oil and gas but no commercial production. At Hoşköy, 4 shallow wells were drilled, none deeper than 136 meters. These also have showings of oil and gas. In the Eregne River Basin, inland in the southwestern part of Thrace, are several structures that merit further examination.

Companies operating in Turkey under the 1954 Petroleum Law have drilled a number of wells: Gilliland, at a location 32 km. (18 miles) south of Iskenderun; American Overseas Development Petroleum, Ltd., 20 miles east of Gaziantep; and Esso Standard (Turkey), Inc., in Thrace.

Besides the areas already drilled, other parts of Turkey are considered to merit attention; The Antalya Basin, the Salt Sea Basin of Central Anatolia, the Lake Van area, the extensive sedimentary area along the Black Sea, and the sedimentary basins of Thrace. From an economic point of view the significance of future discoveries will lie perhaps more in the increasingly large domestic market than in the export market. In world markets Turkish oil would have to compete with the prolific oil

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fields of the Middle East. Oilfields near the Mediterranean or in Thrace would be well located for both domestic and possible foreign markets, whereas fields in the Salt Sea Basin would be well located for the domestic but not for the foreign market. The Black Sea area is a fairly good location, whereas southeastern Turkey, which geologically is the most attractive at present, is a long distance from either domestic or foreign markets.

IRON AND STEEL AND FERROALLOY METALS

Iron Ore

Production, Consumption, and Trade

The production of iron ore was begun in 1937; data from 1939-56 are supplied in table 1 and show that production increased rapidly from 112,000 metric tons in 1946 to a maximum of 953,806 metric tons in 1956. Until 1952 the entire tonnage was obtained from the Divriği mine and was shipped to the Karabük steel plant, 1,000 kilometers distant (by rail). Since 1952 ore has been produced for export from several mines in the Edremit and other areas. Comparative figures on production and sales of state and private sectors in 1955 and 1956 were as follows:

	Production		Sale	
	1955	1956	1955	1956
State.....	528,804	536,353	435,701	433,580
Private.....	345,173	417,453	335,828	343,593
Total.....	873,977	953,806	771,529	777,173

Exports of iron ore for other years are shown in table 5. The Edremit mines are favorably situated for export because of the relative vicinity of the Aegean coast; however, the ore carries arsenic. It is believed that only during periods of high world steel production could Turkish iron ore command a market in Europe and compete pricewise with iron ore from other sources. According to press reports, a new company, named Maden Arama ve Etud, Ltd., Şirketi (Mine Exploration & Investigation Co.) formed by Krupp with several Turkish banks (Eti Bank, Is Bankasi, Sumer Bank, and Emlak Kredi Bankasi) will investigate the Edremit deposits further as part of an overall examination of iron-ore deposits of Turkey, with a view to establishing a second steel plant.

Nature, Location, and Mining of Deposits

The location of principal iron-ore deposits of Turkey is shown in figure 15. Evaluation of the reserves is difficult, because few deposits other than Divriği have been systematically sampled and analyzed. Adding up estimates given in various publications brings the total to 150,000,000 to 200,000,000 metric tons of iron-bearing material. However, these figures (see table 15) should be considered as indicative of possible magnitude in each case rather than reserve tonnages calculated in the usual engineering manner.

A large percentage of the tonnage cannot be considered as ore in the economic sense. The direct-shipping ore may not amount to more than half of the total tonnage, that is, 75,000,000 to 100,000,000 metric tons, with the bulk in the following 2 deposits:

Divriği mine..... 39,500,000
Büyük Eymir mine..... 11,500,000

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TABLE 15. - Iron-ore deposits in Turkey, other than Divriği (Con.)

Province (Il) Name and location	Description
Balikesir (Con.): Pirenli-Altinoluk, 20 km. west of Edremit and 2 km. inland from the Gulf of Edremit on the Edremit-Çanakkali road.	Reserves: Inferred, 160,000 metric tons. Geology: Bedded deposit, somewhat similar to brecciated ores of Eymir deposits but with a larger proportion of limonite. Evidence of ore consists of 2 outcrop ledges and float ore scattered over 200 by 400 meters area. Observed thickness of ledges in situ varies from 1 meter to 2 meters. At Altinoluk a mountain slope going down to Gulf of Edremit is covered with cellular powdery limonite. Ore analysis: Fe, 47.2 percent; SiO_2, 17.84 percent; P, 0.098 percent; S, 0.23 percent. Ownership: Under management of Bereket Limited Şirketi.
Çarmih mine, 23 km. E. of Akçay by way of Balikesir-Edremit road and 23 km. N. of this road on a private dirt road.	Reserves: Inferred, 150,000 metric tons Fe, 56.5 percent; S, 0.64 percent; P, 0.08 percent. Ownership: Izzat Cevat Odabaşi Bros., Edremit.
Hakki Manco mine, 51 km. W. of Edremit and 2.5 to 8 km. from coast.	Geology: There are 3 beds of ore (1) on a plateau at an elevation of 200 meters above sea level, with a reported reserve of 48,000 metric tons of 48-52 percent Fe; (2) a bed of unknown thickness, 118 meters higher in elevation, with 67 percent Fe; (3) a deposit up to 28 meters thick on top of mountain at 418 meters altitude, having an estimated reserve of 500,000 metric tons. Production: It was reported that in 1953 the mine produced at the rate of 30,000 metric tons per year.
Haciveliler, in Ayvacik County	Reserves: Visible, 800,000, and inferred: 8,000,000 metric tons. Ore is said to be magnetite. Ore analysis: 60-65 percent Fe, 0.3 percent P, and 0.45 percent S.
Kocaeli Camdağ-Ferizli	Reserves: Inferred: 8,500,000 tons of siliceous ore, with average iron content of 24 percent. 34,700,000 tons of calcareous ore, with average iron content of 20 percent. 10,000,000 tons of residual ore, with average iron content of 31 percent. Location: Center of ore-bearing area is 28 km. northeast of Adapazari. Deposits extend with interruptions over a distance of 30 km. parallel to Black Sea coast and 15 km. from it. Geology: A series of lenses having a maximum thickness of 10 meters in east and 25 meters in west is intercalated in calcareous grit marls of Middle Devonian.

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TABLE 15. - Iron-ore deposits in Turkey, other than Divriği (Con.)

Province (Il) Name and location	Description
Kocaeli (Con.) Camdağ-Ferizli (Con.)	Oolitic iron in eastern part of belt consists of oolites showing concentric layers of iron carbonate, iron oxide, and chlorite. Original calcareous cement has been replaced by silica or siderite. Amorphous iron replacing organic debris with calcareous cement and abundant fragments of corals, bryozoa, and other fossils is the type found in western part of the belt. There are also some residual ores. Ore analysis: For various types of minerals: Oolitic: Fe 34.68, 37.01; SiO_2 16.05, 14.62; Al_2O_3 39.03, 37.40; CaO 8.66, 9.25; Mn .36, .37; P .42, .47; S Tr., .40 Calcareous: Fe 23.39, 20.87; SiO_2 4.67, 4.54; Al_2O_3 38.14, 40.10; CaO 32.11, 33.64; Mn .51, .50; P .39, .31; S Tr., Tr. Residual: Fe 49.10, 43.36; SiO_2 13.41, 18.46; Al_2O_3 35.10, 36.01; CaO .81, 1.43; Mn 1.04, .25; P .35, .48; S Tr., Tr. Beneficiation: The calcareous and siliceous ores too low grade for economic utilization. Residual ore, although higher in Fe content, is too low grade for direct smelting. Beneficiation by wet methods would also be difficult because of fine distribution of minerals in the clayey matrix.
Malatya: Hasancelebi, in Hekimhan County	Reserves: Inferred, 2,000,000 metric tons. Geology: Zone of mineralization is 40 km. long and 5 km. wide and extends SW. Mesozoic and Tertiary sedimentary and volcanic rocks, which include limestones, conglomerate, gypsum, lavas, tuffs and basalts, are intruded by gabbros, serpentines of pre-Upper Cretaceous, and microsyenites of Upper Eocene to Oligocene. Microsyenite is considered source of mineralization. Ore bodies are at Deveci and Karakuztepe. At Deveci, range of hills of Kara Tepe, Demir Kesen and Karamağara are covered with limonite formed as a result of weathering. Country rock is sedimentary. Karakuztepe has massive magnetite and oligist in a basalt country rock. Ore analysis: Deveci limonite has Fe 39.5 percent, Mn 3.7 percent, MgO 5.2 percent, CaO 2.0 percent, and SiO_2 2 percent; Karakuztepe magnetite-oligist contains 60 percent iron.
Muğla: Besparmak, in Köyceğiz County	Reserves: Magnetite deposit of possibly 2,000,000 tons with 45 to 67 percent Fe.

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TABLE 15. - Iron-ore deposits in Turkey, other than Divriği (Con.)

Province (Il) Name and location	Description
Ankara	
Kirlancik, in Kirikkale County	Reserves: Deposit of possibly 5,000,000 tons, with 62 percent Fe.
Kesikköprü, in Bala County	Reserves: Inferred, 3,000,000 tons. Geology: Magnetite manganese metamorphic deposit, 2 km. long with possibly 5 meters of ore occurring enveloped in eruptive rocks - andesites. Ore analysis: Mn 10 percent, Fe 50 percent. Mining: Mining started in 1951; by 1954 two open pits were in operation, northern one producing hematite and southern one magnetite.
Kayseri:	
Yahyali, in Develi County	Reserves: Inferred, 1,000,000 tons. Geology: Contact pneumatolytic deposit, with foot wall of epidote and garnet rocks and hanging wall of syenite, pyroxenite, skarns, etc. Ore mineral is hematite. Ore analysis: 60-65 percent Fe. Mining: In 1954, deposit was worked in an open pit 40 meters long and 10 meters deep.
Kovali	Geology: Mountains to southwest edge of Yeşilhisar plain consist, in the vicinity of Kovali village, of acid plutonic rocks covered with crystalline calcareous schist. Igneous rock preferably under calcareous schist is altered to earthy limonite in which dense hematite is embedded. These hematite masses are mined in an opencast. Ore analysis: Analysis of mined ore, Fe 63 percent, SiO_2 6 percent, Mn 0.75 percent, CaO 1.5 percent Cu 0.1 percent, Zn 0.1 percent, S tr.
Erzincan	
Cepler, in Ilic County	Reserves: Inferred, 1,000,000 tons of hematite with 60 percent Fe.
Bingöl	
Avnik, in Genç County	Reserves: Indicated, 500,000 tons. Geology: Magnetite deposits are in gneisses enclosed in mica and sericite schists. The magnetite contains apatite as thin bands or disseminated. Quartz and silicate minerals form gangue. Ore analysis: Magnetite with highest apatite content shows Fe, 47.82 percent and P, 4.42 percent. Mineral low in apatite has shown Fe, 58.62 percent, P 0.24-0.54 percent.
Hatay	Deposit of iron and bauxite of possibly 10,000,000 tons near Sincan and 3,000,000 tons of 35-45.5 percent Fe near Azganlik in Dörtyöl County.

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The Divriği deposit is of the contact type, but Büyük Eymir is of sedimentary origin. The Çamdağ-Adapazari area has been examined at various times by the MTA with a view to supplying iron ore to the Karabük steel plant from this area, because it is closer than Divriği. However, the ore examined so far is low grade and not amenable to concentration. Available information on iron-ore deposits, other than Divriği, which is described below, is tabulated in table 16.

Divriği mine is east of the village of Divriği on the railway line between Sivas and Erzurum. Most of the ore is loaded at Cürek railroad station at an altitude of 1,051 meters. The highest opencast level in the principal ore body is at 1,664 meters and the lowest at 1,435 meters.

There are 3 ore bodies, A, B, and C, with total estimated reserves of 39,500,000 metric tons of high-grade ore (Fe, 63 percent). By far the largest is A (Demirdağ), with reserve of 35,000,000 tons of magnetite occurring along the contact of a syenite intrusive mass and limestone beds of Permian age. Ore body A measures 800 by 80 meters at the outcrop and is 200 meters deep. The ore near the surface is good furnace ore but pyrite at depth increases the sulfur content to 0.35 percent. A sintering plant has been installed at Karabük to treat the high-sulfur ore, which is the main reserve of Divriği. Average analysis of ore is: Fe, 66.5 percent; S, 1.6 percent; CaO, 2.5 percent; SiO_2, 2.5 percent; P, 0.7 percent; MnO, 0.6 percent; MgO, 0.5 percent; Al_2O_3, 0.7 percent.

The B ore body (3,500,000 tons of reserves) consists of hematite lenses of varying sizes alined in a direction perpendicular to the main mineralization and over a distance of 700 meters. Average analysis is as follows: Fe, 61.6 percent; S, 0.3 percent; CaO, 2.8 percent; SiO_2, 3.9 percent; MnO, 0.8 percent; MgO, 0.4 percent; P, 0.3 percent. The sulfur content is less than in the A deposit.

C is residual ore (hematite fanglomerate) at the surface southeast of A, covers an area of 10 hectares (25 acres), and in 1950 had an estimated reserve of 1 million tons. The fanglomerate C is won in an open pit between the 1,107- and 1,186-meter levels. Hematite pieces, a few inches to several inches in diameter, are bedded in an earthy mixture of hematite, illite, and kaolinite. One cubic meter of the deposit contains an average of 0.42 cubic meter or 1.2 to 2 tons of ore pieces. The average sulfur content is 0.25 percent. Besides A, B, and C there are 2 small lenses 2 kilometers east of Demirdağ and 4 unimportant deposits at Burunsur, northeast of Demirdağ.

Mining at Demirdağ is by open pit; there are 17 levels in all. To increase production to an annual rate of 400,000 metric tons, ECA-MSA allotted about $2,500,000 for mine development and purchase of equipment. Mine development consisted of driving an underground crosscut from the A ore body to B, so that the latter could be exploited by underground methods. Core drilling was also to be carried out to determine the reserves of the three ore bodies. Equipment procured consisted of two 750-kw. powerplants, 7 compressors, stripping equipment, an ore crusher for the C ore body, a power-transmission line to the A ore body, an aerial tramway, a liquid-oxygen plant, a workshop, and a garage. A new program providing additional mechanical excavating and transport of equipment is underway. The first stage of the program will increase annual production from 500,000 tons to 700,000. The final objective is an annual output of 1,100,000 tons a year, to be achieved in December 1958. The cost of production of ore in 1952 was estimated at TL 9.46 ($3.37) per ton at the mine.

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Pig Iron and Steel

Raw Materials

The known iron-ore reserves of Turkey, although modest by world standards, are adequate to satisfy, for many decades, the needs of the Turkish steel industry at the present scale of consumption or with a moderately expanded one. The reserve situation becomes more favorable when smelting methods, such as the Krupp-Renn, are considered, because much of the known iron ore in Turkey is too high in silica to be suitable for use in blast furnaces.

The bituminous-coal reserves of Turkey are estimated at 363 million tons "measured" and 713 million tons "indicated and inferred." Although the percentages of these quantities that are of coking quality are unknown, the reserves of metallurgical coal are believed to be adequate to meet the modest needs of Turkey's iron and steel industry. The concentration of all bituminous coal in one area, the Zonguldak Basin, creates an unfavorable factor because of the distance to Divriği deposits. Deposits of limestone are believed to be widespread. More than enough manganese is produced for the requirements of the steel industry. Much of the needed refractory material is also produced in Turkey, although refractory clays and bricks are imported. Imports of refractory clays are small (see table 4); refractory brick imports in 1956 totaled 2434 tons valued at TL 1,122,504.

Production

Almost the entire iron and steel output of Turkey comes from the Karabük plant, owned by the Turkish Iron and Steel Industry Association. Annually a few thousand tons of steel and a few hundred tons of alloy steel are also produced in a plant at Kirikkale. Production of pig iron, steel castings, and ingots and semifinished and finished steel products in Turkey for 1940-56 is listed in table 16. Except for 1942-46, when the yearly output of pig iron was less than the 83,950 tons average for 1940-41, a gradual increase in pig-iron production occurred, rising to a maximum of 219,442 tons in 1956. The increase in pig-iron and ferroalloys production is reflected in steel ingots and castings, which rose from 37,500 tons in 1940 to 192,512 in 1956; and finished iron and steel products, with corresponding totals of 7,500 metric tons in 1940 and 154,112 tons in 1956.

Comparison of the total production of pig iron and steel ingots and castings for 1937-56 indicates that not all of the pig iron has been utilized in steelmaking. Some pig iron is used at Karabük for casting pipes, and an average of 6,000 tons is shipped annually to the Istanbul area for use by local foundries. The remainder presumably has been exported (see table 2). One objective of the present expansion plan is to bring about a better balance between pig iron and steel production by increasing the rolling capacity, which has been the bottleneck of the operations.

Of the finished iron and steel products, bars and sections constitute the largest percentages, followed by plates, sheets and strips, and rails and railway materials. Domestic production of these items does not meet consumption demands and is supplemented by imports, tabulated by commodities in table 17 and by countries of origin in table 18.

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TABLE 16. - Production of iron ore, pig iron,[2] and steel in Turkey, 1940-56
(1,000 metric tons)

Source: British Iron and Steel Federation, Statistical Yearbook, part II Overseas, 1951 and 1954 and others.

Year	Iron ore	Pig iron and ferro-alloys	Steel ingots and castings	Semi-finished steel	Finished iron and steel				Cast pipe
					Bars and sections	Plates, sheets and strips	Rails and railway materials	Total	
1940	130.4	83.4	37.5	11.5	6.8	-	0.7	7.5	2.8
1941	60.8	84.5	33.1	35.2	27.9	1.6	0.4	29.9	4.8
1942	19.1	65.8	50.1	27.8	25.0	4.1	1.3	30.4	4.9
1943	91.8	55.3	42.7	36.2	29.4	5.7	1.2	36.3	6.2
1944	90.4	69.8	60.8	42.8	33.3	5.3	2.8	41.4	7.8
1945	125.7	69.5	64.2	43.6	37.2	5.4	5.2	47.8	4.7
1946	112.2	79.3	80.0	58.2	38.4	8.9	9.2	56.5	4.6
1947	149.4	99.0	92.7	70.2	55.3	13.8	2.7	71.8	6.7
1948	191.7	100.7	101.7	72.4	56.9	9.6	8.6	75.1	7.4
1949	210.9	114.2	103.0	66.1	49.6	11.1	7.6	68.3	10.9
1950	233.6	113.5	90.8	66.9	55.7	11.8	10.5	78.0	8.6
1951	225.8	153.4	135.4	92.0	68.5	14.7	22.2	105.4	8.9
1952	481.8	196.1	153.5	99.0	79.7	18.4	14.8	112.9	7.1
1953	497.1	212.5	162.6	134.4	101.4	22.4	4.5	128.3	6.8
1954	586.2	194.3	168.9	122.5	114.8	24.0	3/1.1	139.9	10.7
1955	874.0	202.0	188.0	(1)	(1)	22.6	6.8	(1)	16.5
1956	953.8	219.4	192.5	154.1	110.8	31.0	5.2	4/154.1	32.2

1/ Not available.
2/ Includes ferroalloys.
3/ Rail ties only.
4/ Including 7,089 tons of semiproducts.

TABLE 17. - Imports into Turkey of iron and steel, by commodities, 1937-56
(Metric tons)

Source: 61

Year	Pig iron, ferroalloys, and ingots	Bars, shapes, and sections	Plates, sheets, and strips	Tinplate	Rails and accessories	Wire	Tubes, pipes, and fittings	Scrap	Total
1937	16,618	60,088	25,918	-	21,349	2,816	15,296	133	142,218
1938	4,562	79,864	33,586	-	25,893	2,460	20,462	24	166,851
1939	2,487	57,436	26,323	-	34,380	2,105	23,983	233	146,947
1940	7	6,946	7,720	2,786	606	271	1,438	52	19,826
1941	511	3,177	1,634	6,145	1,164	1,373	1,182	335	15,521
1942	-	6,016	4,104	2,493	1,898	2,713	2,125	26	19,375
1943	383	13,637	8,258	1,309	7,902	4,769	4,851	483	41,592
1944	1,151	8,348	5,622	4,501	12,137	1,336	2,624	176	35,895
1945	795	5,450	5,698	2,917	516	949	3,893	185	20,403
1946	411	14,817	14,018	3,243	7,150	4,403	4,805	9	48,856
1947	295	27,773	17,341	8,349	7,882	8,547	12,317	43	82,547
1948	672	24,724	8,882	12,282	5,581	2,950	21,607	58	76,756
1949	670	23,459	13,580	13,439	1,655	5,857	30,629	17	89,306
1950	420	45,319	24,809	14,463	66,048	4,541	29,700	5	185,305
1951	113	48,487	19,464	9,224	14,808	3,170	36,516	13	131,795
1952	117	90,211	32,056	21,839	2,730	3,968	42,042	2	192,965
1953	246	158,430	38,391	38,655	30,588	3,171	48,196	45	317,722
1954	968	77,051	21,977	27,275	4,926	2,470	39,297	-	173,964
1955	134	110,797	16,990	19,876	19,366	8,618	56,048	5	231,834
1956	2,464	41,303	18,467	17,699	13,836	5,928	46,118	-	145,783

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TABLE 18. - Imports into Turkey of iron and steel, by countries of origin, 1937-56
(Metric tons)

Source: 61

Year	Austria	Belgium-Luxembourg	Czechoslovakia	France	Germany	Italy	Nether-lands	Poland	Sweden	United Kingdom	United States	Other countries	Total
1937	281	7,418	525	1,541	61,515	843	-	777	255	4,904	31,730	32,429	142,218
1938	226	5,938	4,049	3,563	92,501	351	-	16,635	176	3,849	20,979	18,584	166,851
1939	-	1,084	1,390	104	91,725	9,815	57	23,900	229	958	8,274	9,411	146,947
1940	-	479	205	120	1,545	3,279	4	-	44	3,623	9,855	672	19,826
1941	-	-	942	-	1,115	215	-	-	655	8,012	1,987	2,595	15,521
1942	-	-	2,077	-	6,052	1,115	-	-	516	5,981	849	2,785	19,375
1943	-	5	1,978	-	29,002	1,869	-	-	240	3,156	1,022	4,320	41,592
1944	-	5	3,074	-	19,222	15	-	-	42	8,030	1,832	3,675	35,895
1945	-	-	-	-	65	5	-	-	253	3,463	14,404	2,213	20,403
1946	-	1,198	51	-	2	892	-	-	669	5,936	39,781	327	48,856
1947	158	12,613	9,491	3,396	-	1,545	176	693	352	9,566	43,218	1,339	82,547
1948	2,134	14,427	555	6,253	26	214	367	5,061	484	16,811	29,673	751	76,756
1949	2,438	7,891	108	13,772	9,220	2,959	2,751	6,350	1,494	20,282	17,210	4,831	89,306
1950	1,085	22,198	431	8,026	92,778	139	2,817	1,969	619	8,301	44,918	2,024	185,305
1951	2,132	32,430	194	14,735	57,414	4,813	1,500	98	1,218	5,252	9,984	2,025	131,795
1952	2,157	77,082	99	13,517	62,686	5,175	3,750	1,883	990	7,121	17,030	1,475	192,965
1953	6,653	75,876	145	54,965	124,492	1,382	2,737	1,198	1,009	11,555	35,240	2,470	317,722
1954	7,466	12,234	9,825	34,391	54,360	1,707	701	1,410	893	11,932	28,645	10,400	173,964
1955	1,952	9,055	23,127	15,054	66,492	39,746	3,067	16,802	294	8,208	16,187	31,850	231,834
1956	5,928	11,648	4,621	2,873	51,839	28,579	2,132	4,226	245	5,202	20,071	18,409	145,783

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Consumption and Trade

Addition of finished-steel production and imports for 1950-56 indicates an average annual apparent consumption of about 335,000 metric tons. This may exceed the country's normal consumption, because imports for industrial expansion have been unusually large since 1950.

Iron and steel imports into Turkey (table 17) have consisted of small rounds and bars, angles, ties, plates, thin sheets, and rails, for which Karabük production is either insufficient or completely lacking. Government policy is to exclude products that Karabük can feasibly manufacture. By and large, imports are drawn from European countries (table 18). The value of iron and steel imports for 1950 and 1952-56 has been as follows: 1950, TL 57,969,202 ($20,703,286); 1952, TL 105,925,102 ($37,830,394); 1953, TL 141,278,061 ($50,456,450); 1955, TL 113,273,847 ($40,454,945); 1956, TL 81,381,517 ($29,064,838).

Turkey does not export iron and steel products, but pig iron and scrap have been exported at times (table 5).

Scrap stocks in Turkey are unknown. Consumption for production of pig-iron and steel ingots and castings in the Karabük plant during 1947-54 is shown in table 19. Undoubtedly some scrap must also be used by the rerolling industry of Istanbul.

TABLE 19. - Materials consumed in producing pig iron,2/ steel ingots, and castings in Turkey, 1947-54 and 1956
(Thousand metric tons)

Source: 62.

	1947	1948	1949	1950	1951	1952	1953	1954	1956
Production of pig iron and ferroalloys	99.0	100.7	114.2	113.5	153.4	196.1	216.5	196.1	219.4
Materials consumed:									
Iron ore	116.4	114.4	129.4	122.8	177.3	250.7	318.1	294.7	120.2
Sinter	15.7	27.5	30.9	29.3	34.3	32.8	2.8	-	204.0
Manganese ore	3.4	5.0	4.3	3.4	4.0	5.8	9.8	7.8	(1)
Limestone	-	72.6	48.4	69.1	45.7	65.9	73.6	73.8	77.1
Scrap	8.8	12.2	13.4	12.2	12.8	16.4	13.5	6.4	(1)
Coke	97.2	109.1	116.1	107.3	145.5	189.6	196.9	178.4	212.5
Production of steel ingots and metal for castings	92.7	101.7	103.0	90.8	135.4	153.5	162.6	168.9	192.5
Materials consumed:									
Pig iron	69.0	91.1	81.7	68.2	102.8	127.2	128.3	138.5	183.9
Ferroalloys	0.6	0.5	0.5	0.8	0.8	1.5	1.2	1.9	}
Scrap	21.5	13.0	25.6	26.0	35.5	27.5	33.9	26.4	} 80.0
Iron ore	n.a.	20.8	19.0	17.2	25.2	37.3	43.0	43.7	}

1/ Not available.
2/ Includes ferroalloys.

Steel Mills

Other Than Karabük

Steel is produced at a plant in Kirikkale with a melt capacity of 5,000 tons a year, using Karabük pig iron and scrap. Early in 1957 Stahlwerke Sudwestfalen, the

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West German special steel producer, and the State-owned company operating Kirikkale plant, formed a company called Çelik, Ltd., Şirketi. Çelik, Ltd., will increase the capacity of the plant threefold and concentrate on the high-grade and special-steel production.

The Sumer Bank in 1956 started building a welded-tube mill (Izmit Dikilsi Boru Fabrikasi) at Izmit with an initial capacity of 15,000 tons of 1/2- to 2-1/2-inch tubes per year. The capacity can be expanded to 65,000 tons. The German firm Mannesman, A. G., is aiding in constructing the plant, which shall cost TL 6,000,000.

Some 21 rolling mills with an annual capacity of 60,000 tons are operated privately. Of the total, 42,800 tons is in Istanbul, 7,400 in Karabük, and the remainder in Ankara, Konya, and Kayseri. These plants do not operate at capacity. In the Istanbul area are also 30 foundries, which remelt annually about 6,000 tons of pig iron and cast machine parts.

Karabük

Karabük is an integrated steel plant, consisting of coke ovens, blast furnaces, open-hearth furnaces, rolling mills, foundry, powerhouse, workshop, and other facilities employing nearly 5,000 people. In 1952-53, as a result of ECA aid, a sintering plant was added to treat high-sulfur magnetite ore. The plant, which has been in operation since 1939, was designed by Brassert and constructed by British firms. The general type of equipment and its capacity as of January 1, 1957, follows:

1. Coke-oven and byproduct plant, with a total capacity of 600,000 tons of coke yearly.

2. Two blast furnaces, with an annual capacity of 150,000 tons each.

3. Crushing, screening, and sintering plant, with an annual crushing and screening capacity of 225,000 to 250,000 tons per year and a sintering capacity of 200,000 to 225,000 tons per year.

4. Four open-hearth steel furnaces, with an annual capacity of 180,000 tons.

5. Rolling mills:

   a. 450 mm. (28-inch) blooming and section mill, of 180,000 tons annual capacity.
   b. 400- to 300-mm. (16- to 12-inch) merchant mill, of 100,000 tons annual capacity.
   c. Sheet mill, of 20,000 tons annual capacity.

6. Pipe foundries:

   a. Sand-casting annual capacity, 10,000 tons.
   b. Spun-casting annual capacity, 15,000 tons.

7. Sulfuric acid and superphosphate plant; acid 18,000 tons and superphosphate 22,000 tons per year.

8. Powerplant, 20,000-kw.

9. Work and machine shop.

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10. Auxiliary departments:

    a. Cast-iron foundry, of 5,000 tons annual capacity.
    b. 3-ton Birleg-Lectromelt electric furnace for making about 800 tons of high-carbon steel yearly.
    c. Laboratories.

Coke Ovens. - Each of 4 batteries has 21 ovens; 1 battery was built by Simon Carves and 3 by Didier. Coke production in 1956 was 518,500 tons, including 15,715 tons of fines. Of this quantity, the blast-furnace demand was 212,456 tons, the remainder being available for industry and domestic heating. Each oven is 0.45 meter wide, 4.5 meters high, and 13.2 meters long and takes 22.5 metric tons of coal. The coke is pushed out from the side by rams in the usual manner. Coal byproducts are recovered, and clean gas is "sold" to the reverberatory furnace. A gas holder has a capacity of 10,000 cubic meters.

Byproducts are tar (80 tons per day), benzol (20 tons per day), and ammonia. A continuous distillation plant uses the tar to produce the following commodities:

Benzol	Sold to the State railway for treating timber.
Naphthalene	Crude naphthalene is refined in a sublimator plant to produce 1,000 tons of pure naphthalene per year.
Toluol	600 tons of pure toluol per year.
Heavy oil Wash oil Anthracene oil	Used principally for treating railroad ties.
Pitch	Constituting 55 percent of the crude tar; used by the Government in road building.

Blast Furnaces. - Two Brassert-designed furnaces have 8 tuyères, a 4.57-meter (15-foot) hearth, 5.79-meter (19-foot) bosh diameter, 24.38-meter (80-foot) height, and 390-cu. meter (13,741-cu. ft.) capacity. They were built by Ashmore Benson. The layout of the furnaces is good, and ample space has been provided around each one.

Each blast furnace has 3 stoves, 5.8 meters in inside lining diameter and 24 meters in height, with 77,200 square meters of heating surface. The cycle is 2 hours on gas and 1 hour on blast. The average blast temperature is 500° C. and the maximum 825° C. The blast is delivered by 3 steam-turbine-driven blowers, each with a capacity of 900 cubic meters of air per minute. The blast-furnace gas is stored in 2 holders, each of 30,000 cu. meters volume.

Materials consumed in producing pig iron, 1947-54 and 1956, are shown in table 19. Since 1954 consumption of sinter has increased considerably. In 1956, 351,060 tons of iron ore and sinter was smelted, the sinter amounting to 204,014 metric tons. The remainder of the ore was used as mined, 94,162 tons coming from the Divriği mine, also the source of the sintered ore, and 26,061 tons from privately owned mines.

A blast-furnace charge is made of 6,600 kg. iron ore, 1,500 kg. limestone, 4,000 kg. coke, and 125 kg. manganese ore. Limestone is obtained from a quarry 25 km. from the plant on road to Zonguldak. The coke has 18 percent ash; coke consumption is 900 kg. per ton of pig.

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Except for the coke, the charge is made up in a bin and fed to the furnace by skip cars taking 2 tons of coke and about 4.3 tons of ore mix. In practice, the coke is not weighed, but 2 skipfuls are fed to the furnace followed by 2 weighed skips of charge, consisting of iron ore, limestone, and manganese ore. Hot metal is sent to open-hearth furnaces or to pig-casting machines. Of 2 continuous bank casting machines, 1 is a spare. Each bucket in the casting machine is automatically sprayed with lime. Each pig weighs 50 kg. The average analysis of the pig iron in 1956 was 93.74 percent Fe, 4 percent C, 1 percent Si, 0.06 percent S, and 0.15 percent P.

Normally both blast furnaces do not run continuously, because the capacity of the sintering machines is not large enough to sinter enough sulfur-bearing Divriği ore, and the mine is not capable of producing enough extra tonnage of sulfur-free ore.

Sintering Plant. - Two types of ore are smelted - hematite and magnetite. The latter has 64 percent Fe and low phosphorus (0.06 percent), but it is high in sulfur (about 2 percent). The hematite contains 62 percent Fe, with negligible sulfur and a P content similar to that of the magnetite. To reduce the sulfur content of the magnetite, a sintering plant has been constructed with ECA aid. The plant, built by Lurgi, consists of a crushing and screening section, with a daily capacity of 750 tons, in addition to the sintering unit. The plant has been in operation since February 1953.

To size the ore, both hematite and magnetite are crushed separately and screened to the following sizes:

0 - 10 mm. Both magnetite and hematite fractions go to the sintering plant.

10 - 25 mm. Hematite goes directly to the furnace. Magnetite goes to rolls for further crushing, then to the sintering plant.

25 - 50 mm. Hematite goes directly to the furnace. Magnetite goes to rolls for further crushing, then to sintering plant.

50 - 90 mm. A small amount of this size, plus the hematite, will be sent to the reverberatory furnace.

The sized magnetite is fed to a Dwight-Lloyd continuous sintering band 2 meters wide and with 34 square meters suction surface. The charge consists of magnetite and sintered fines, 94 percent; and coke and flue dust, 6 percent. In addition, 20 tons per day of roasted pyrite from the sulfuric acid plant is added. The charge is wetted just before it is fed to the sintering band. In the initial stages of operation the recirculating fine sinter was excessive; about 30 percent of the sinter was too fine and had to be resintered. However, further experimentation undoubtedly has improved this. The plant is well designed and generously equipped. The flowsheet is shown diagrammatically in figure 16.

Steel Furnaces. - Steel is made in four basic open-hearth furnaces (lined with magnesite brick) built for hot-metal charge by Wellman-Smith-Owen Engineering Corporation, Ltd. Each furnace has a capacity of 65 metric tons per heat (at present 75 tons is charged), and 2-1/2 heats are obtained per 24 hours. The maximum width of the furnace is 3.2 meters, the melt area 29 square meters, and depth of melt 85 centimeters. Originally, the roofs were made of silica brick, but these have been changed to chrome-magnesite brick. The basic brick roof is said to withstand 800 heats without repair. The furnace bottom and walls need minor repairs after 300 to 400 heats. Dolomite stampings are used in the furnace bed. Three furnaces are in

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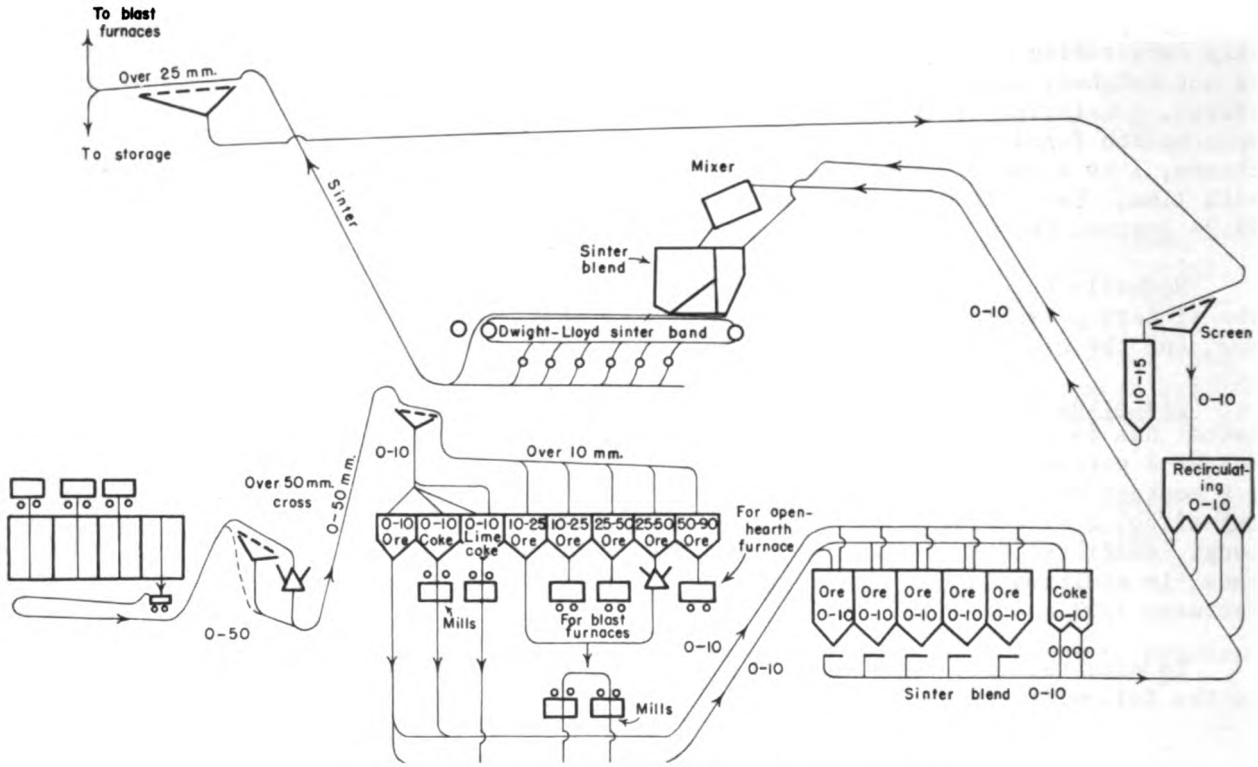

FIGURE 16. - Flowsheet of Karabük Sintering Plant.

operation, and one is spare. A mixture of blast-furnace and coke-oven gases (250 B.t.u.) is burned for heating the furnace. The flow of hot gases through the checkers is reversed every 15 minutes.

The open-hearth charge consists of 50 to 60 tons of molten metal, 15 tons of scrap, 3 tons of limestone, and 10 to 12 tons of iron ore. For each ton of pig iron 200 to 300 kg. of iron ore is added, because of the small quantity of scrap used. The furnace is charged by two 5-ton cranes. Material consumed for steelmaking during 1947-54 and 1956 is given in table 19. The total iron recovery (1956) in the open-hearth plant was 96.1 percent.

The steel is poured in 1-1/2-ton ingots (150 cm. long) and sent to the stripping shops, where hydraulic cranes strip the molds. Ingots are preheated in two furnaces before being rolled, but soaking pits are under construction or already completed.

Rolling Mill. - Built by Davy United, the rolling mill in 1956 received 186,440 tons of ingot and produced 154,112 tons of rolled products (see table 16), the balance being recirculated scrap. The yield was 82.5 percent of input and consisted of 66,422 tons round bars, 21,268 sheets, 20,651 profiles, 15,565 angles, 8,168 tons square sections, 6,319 strip, 5,230 rails and accessories, 3,390 plates and 7,089 tons of semiproducts. Two ingot-heating furnaces (each 25 tons per hour capacity) are fired with mixed gas. The ingots go to a 3-high, 450-mm. (28-inch) mill, consisting of 1 roughing (blooming) stand and 3 stands of rail and structural mills. This mill and the 400-mm. (16-inch) mill are equipped with reversing tables. Products rolled at the 450-mm. mill are: Beams, 16 to 38 cm.; angles, 75- by 100-mm. to 90- by 150-mm.; channels, 16 to 30 cm.; rails, 39.5 to 46 kg.; sheet bar, 488- by 190-mm. (16- by 5/8-inch).

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The 400-mm. mill is 3-high and has 3 stands; the first roughs for the other 2 stands and for the 300-mm. (12-inch) mill, which is 3-high and has 5 stands for making different small sections. Each of the 400- and 300-mm. stands has 1 preheating furnace. The one for the 400-mm. mill has a capacity of 14 tons per hour. Products of the 400- and 300-mm. mills are as follows:

400-mm. mill: Rounds, 24 to 80 mm.; flats, 35 by 10 mm.; angles, 26 by 26 mm.; channels and beams, 65 mm.

300-mm. mill: Rounds, 22 mm.; flats and angles.

The sheet mill is a 1-stand, 760-mm. (30-inch), 2-high mill and is provided with reversing tables and preheating furnace. The mill rolls sheets 1 meter wide and 0.75 to 4 mm. thick. Annealing temperature is 610° C. and annealing time 14 to 15 hours.

Pipe Foundries. - In 1956 the foundry received 35,564 tons of foundry pig iron and 11,131 tons of pipe scrap, rolling mill, and ingot scrap. The product consisted of 12,395 tons of sand-cast pipe, 14,212 tons of spun pipe, and 5,566 machine parts. Spun pipes are made in 3 vertical machines in 55- to 600-mm. diameters. The foundry has also 4 cupolas for melting - 2 melt 7 to 8 tons of pig iron per hour, and 2 melt 3 tons per hour. Facilities are also available for casting pipe fittings.

Sulfuric Acid and Superphosphate Plant. - The sulfuric acid is made from pyrite and sulfur and is used in manufacturing ammonium sulfate and superphosphate. The sulfuric acid plant has a producing capacity of 1,000 tons of 60° B. and 200 tons of 66° B. acid per month.

In 1956 the acid plant received 7,960 tons of sulfur ore and 1,358 tons of pyrite to produce 16,670 tons of 60° B. and 5,032 tons of 66° B. sulfuric acid. The superphosphate plant received 5,211 tons of 60° B. sulfuric acid and 6,059 tons of phosphate rock to produce 10,189 tons of superphosphate.

Powerplant. - Steam is raised by 4 International Combustion water-tube boilers, 1 of which is a spare; these are fired with a mixture of blast-furnace and coke-oven gases but can also use powdered coal. Each boiler raises 25 tons of steam per hour at a pressure of 375 lb. per sq. in. and a temperature of 725° F. Two Fraser & Chalmers 12,500-kv.-a. turbines direct-connected to General Electric a.c. generators running at 3,000 r.p.m. generate 20,000 kw. Each generator produces 2,186 amperes at 3,300 volts and 50 cycles. The powerhouse auxiliaries are supplied from two 3,300/380-volt, 3-phase transformers, each of 1,000-kv.-a. capacity. Another transformer (3,300/380-volt, 3-phase, 500-kv.-a.) supplies the blast furnace with other local requirements adjacent to the powerhouse. In addition, 2 d.c., 750-kw. generators are driven by synchronous motors.

Expansion Program at Karabük

The program may be divided into two phases. Phase 1, currently underway, has the goal of producing 400,000 tons of steel ingots and phase 2 the objective of producing 600,000 tons of ingot steel and 675,000 tons of pig iron. The entire expansion program will cost TL 346,000,000 or $123,570,000, of which approximately $59,000,000 will be in foreign exchange. Repayment will be mostly in future production of iron ore, chrome ore, pig iron and blister copper. Phase 1 of the program involves the following:

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Sintering Plant. - Of the iron ore supplied to the mill nearly 70 percent must be sintered to eliminate sulfur, and it is unlikely that Divriği mine can supply continuously additional sulfur-free ore. Therefore, contracts have been let for expanding of the sintering capacity to 775,000 tons, scheduled to be completed in December 1958.

Steel Mill. - The expansion now in hand will increase open-hearth capacity from 180,000 tons to 400,000 and is scheduled for completion in December 1958. A new 150-ton-per-heat furnace is being installed, which may come into operation during 1958. When this furnace is in operation, it is planned to enlarge 2 of the 4 existing open-hearth furnaces from the present 65 tons per batch to 150 tons per batch. Expansion of the open-hearth furnaces (including phase 2) will cost TL 54,000,000 ($19,286,000), of which nearly $9,000,000 is in foreign exchange. The firm of Friedrich Krupp is the contractor and will be paid in chrome ore and blister copper.

Rolling Mills. - The expansion program currently underway involves the installation of a new 914- by 2,159-mm. (36- by 85-inch) blooming mill of 600,000 tons capacity and modifications to the existing 450-mm. mill to roll 300,000 tons. This program is expected to be completed in 1957. The capacity of the merchant mill will also be increased to 230,000 tons by addition of continuous bar and skelp mill - this work to be completed in December 1959.

Pipe Foundry. - A horizontal-spun-pipe foundry with a capacity of 90,000 tons per year was contracted for in early 1957.

Miscellaneous Equipment. - Krupp has also contracted for miscellaneous auxiliary equipment for the blast furnace and steel mill, consisting of ore bridge, ore cars, service cars, transfer and casting ladles, ingot-casting cars, straightening machines, and additional equipment in the hauling, water, and power systems, when steel-mill expansion to the 600,000-ton capacity is undertaken.

Phase 2 of the program involves the following additions, which, except for the blast furnace and steel mill, have not been contracted for.

Blast Furnace. - Addition of a third unit of 300,000-ton-per-year capacity was contracted for by Friedrich Krupp in mid-1957 and is scheduled to be completed in June 1959. Pig iron from the furnace will pay for the foreign exchange component of the costs. It is expected that about 190,000 tons of pig iron will be available in excess of quantities required for 600,000 tons of billet and foundries.

New coke ovens will increase the capacity by one-half - from 600,000 to 900,000 tons - which must be completed simultaneously with the third blast furnace.

Steel Mill. - Increase from 400,000 to 600,000 tons was contracted for by Krupp in February 1957 and is scheduled to be completed in December 1959.

New Gray-Iron and Cast-Steel Foundry. - 20,000 and 10,000 tons of annual capacity, respectively.

Structural Steel Fabricating Shop. - Expansion from 1,200 to 1,800 tons to 4,800 to 7,200 tons per year.

Soaking Pits. - 600,000 tons capacity compared with the present 400,000 tons.

Divriği Iron-Mine Expansion. - 500,000 and ultimately 1,100,000 tons annual production.

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Ferroalloy Metals

Chromite

Production

Regular production of chromite in Turkey began in 1860 with operation of the Bursa deposits discovered in 1848. Before World War I, Turkey supplied about 60 percent of the world requirements of chromite, but the discovery and development of deposits in other parts of the world caused it to lose some markets for its ore. Turkish production during and immediately after World War I was small. In 1927 a French company (Société Minière de Fethiye) was formed to produce chromite. This company's output eventually rose to 80,000 to 90,000 tons annually. The second phase of increased production came about as the Güleman mine in Eastern Turkey was developed and placed in operation early in 1936.

Production of chromite in Turkey since 1938, compared with the world total, is reported in table 20. During the last few years a significant increase in output has occurred, and Turkey has become an important world producer of metallurgical chromite and a principal source of United States imports (see figs. 17 and 18). Recent high demand for chromite, resulting in good prices for the ore has been the principal factor in the rapidly increased annual production. Furthermore, the favorable price structure brought in many new private companies, so that production from privately owned mines is now larger than from State-owned mines.

TABLE 20. - Chromite production in Turkey and United States imports from Turkey, 1938-56
(Metric tons)

	Production by Eti Bank	Total production3/	Percentage of world production	United States imports
1938.....	(1)	213,630	19.0	20,719
1939.....	(1)	183,284	16.5	16,899
1940.....	(1)	169,823	11.6	71,205
1941.....	63,996	135,714	7.7	56,104
1942.....	31,165	116,342	5.7	108,451
1943.....	60,030	154,512	8.5	82,350
1944.....	67,684	182,108	13.0	81,608
1945.....	69,689	148,069	13.5	64,269
1946.....	51,299	103,059	8.6	8,178
1947.....	51,717	156,603	9.2	1,016
1948.....	99,034	285,725	13.6	299,956
1949.....	172,689	451,566	21.7	250,204
1950.....	2/165,968	422,529	18.2	236,148
1951.....	2/159,623	619,420	21.5	304,835
1952.....	2/179,503	806,911	20.4	420,550
1953.....	183,698	912,523	19.2	512,665
1954.....	132,753	561,549	16.5	276,369
1955.....	(1)	644,331	18.4	371,741
1956.....	272,440	710,959	18.7	427,886

1/ Not available.
2/ Totals for 1950, 1951, and 1952 include, respectively, 7,641, 26,388, and 34,592 tons of chrome concentrate.
3/ Preponderantly Metallurgical grade.

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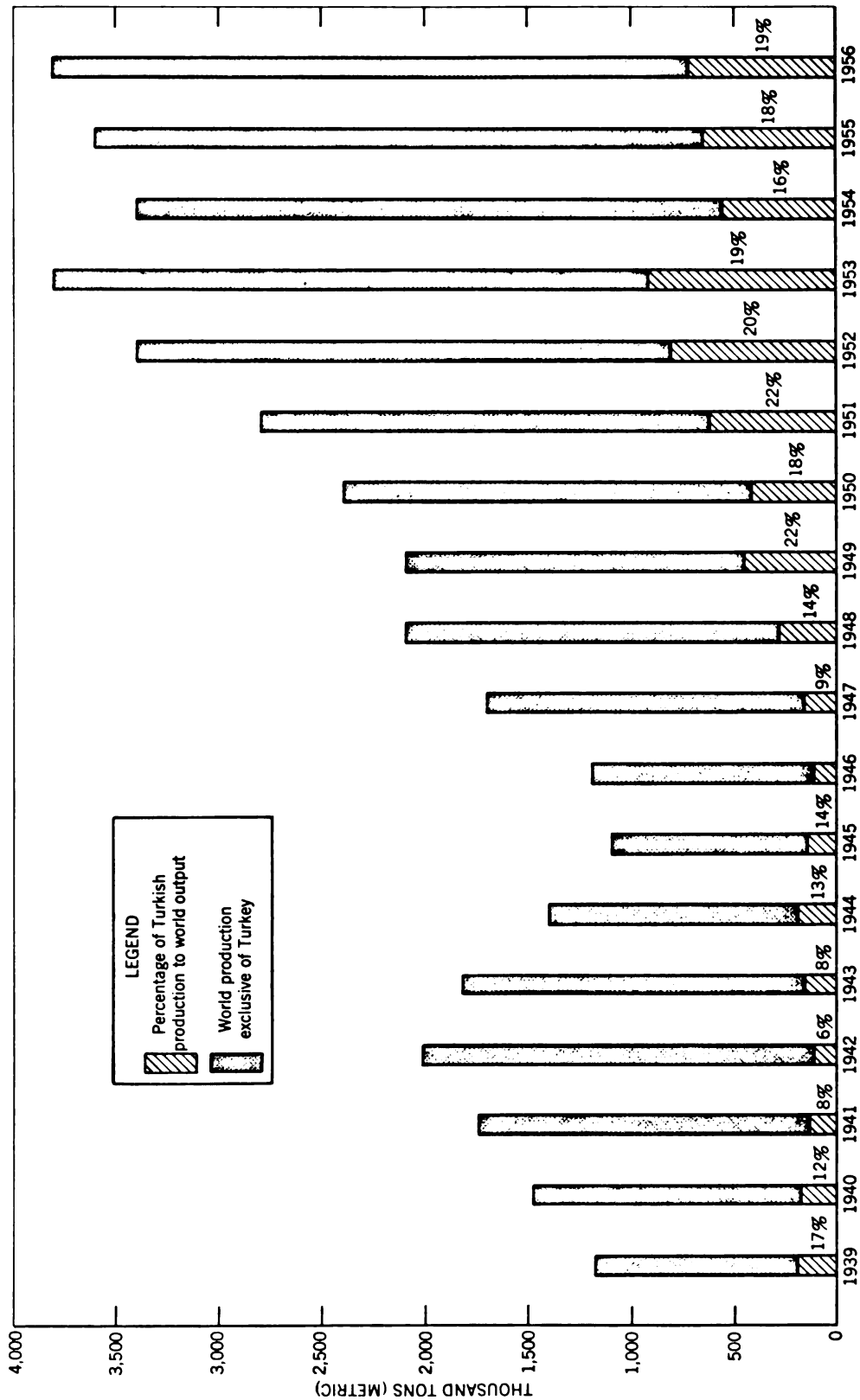

FIGURE 17. - World and Turkish Chromite Production, 1939-56.

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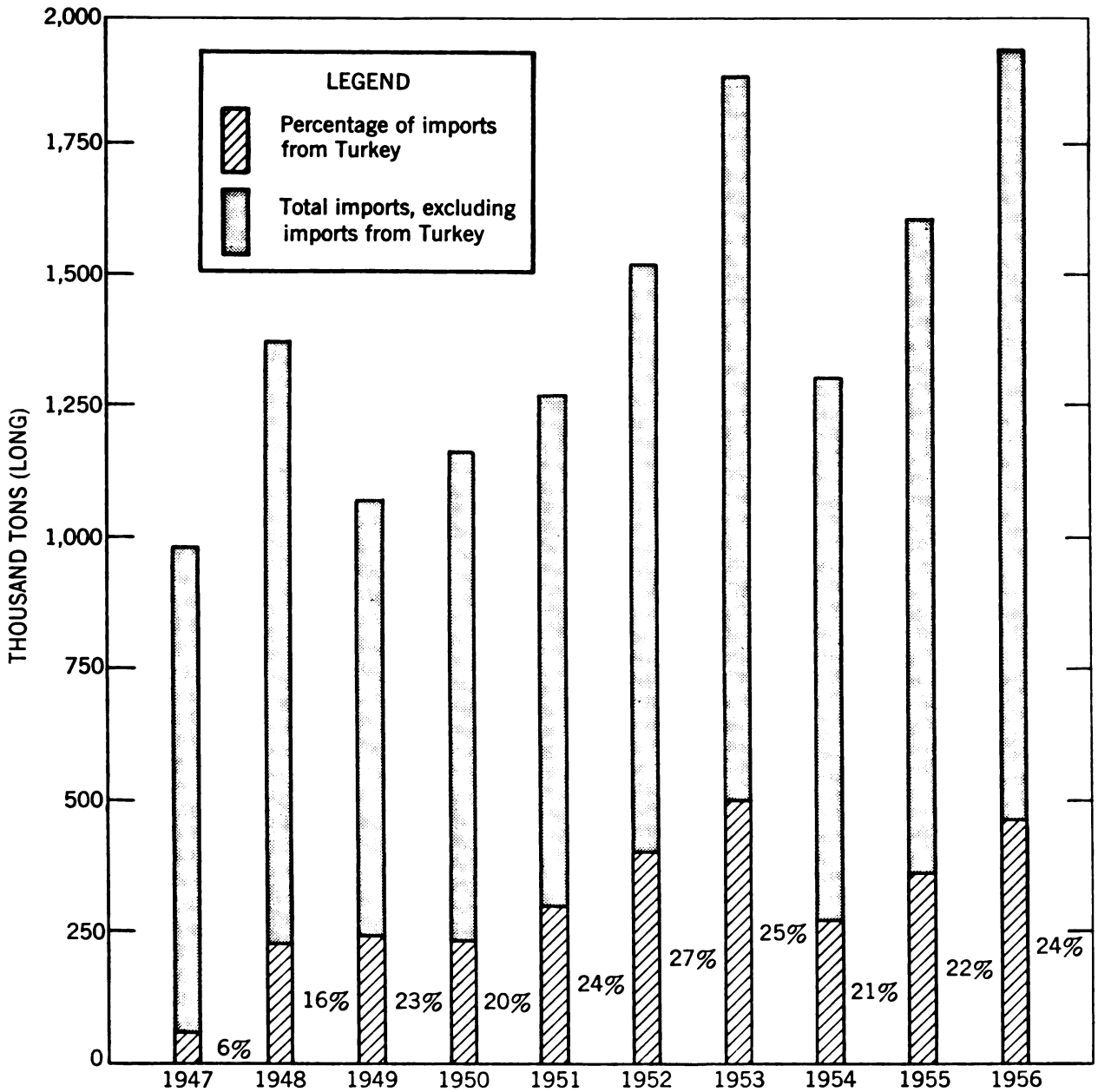

FIGURE 18. - United States General Imports of Chromite From Turkey and Total United States Imports From All Countries.

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Maintenance of the present scale of production depends on several factors, including ore reserves and the price consumers are willing to pay for Turkish ore. Reserves are large enough for maintaining a production rate comparable to 1953 for several years. However, the approaching depletion of the Gölalan ore body, which has been the mainstay of Eti Bank's production at Güleman, will necessitate working many ore bodies to obtain the same quantity of ore as is now won from Gölalan. The premium paid on the high chrome-iron ratio has been an important factor in increasing production and improving the competitive position of the Turkish ore. However, a tendency is evident in the United States to use more of the cheaper ores, which do not have a high chrome-iron ratio. To the extent that low-grade chromite is used for making ferrochrome, the United States market for Turkish ore will decrease and result in a recession in the Turkish industry. When prices drop, as they did in 1954, many small private firms cannot produce profitably. On the other hand, transportation is one of the major items in the f.o.b. port price of ore, and in time it may be possible to decrease transportation costs to such an extent as to improve the competitive position of Turkish chromite.

Ferrochrome is not produced in Turkey, but plans for constructing a plant near Antalya were announced in 1957. The plant is a joint venture of Eti Bank and French interests and should have an annual capacity of 8,000 tons.

The largest single chromite producer in Turkey is Eti Bank, which obtains its entire output from the Elazığ deposits. Private producers operate nearly 45 mine groups, of which 12 or so are well established, with an annual production of 10,000 to 50,000 tons. Participation of private companies in total production has increased gradually, as is seen in table 20. Production in the various areas or mine groups and the important companies operating in each area are stated in table 21.

All private chrome producers are members of Turkish Chrome Ore Producers Association, a Government-sponsored body whose principal function is to follow the trend of the world chromite market and register contracts for sales of Turkish ore. This means that the association controls and establishes minimum export prices, within the framework of the directives of the Ministry of Economy and Commerce. Currently 102 companies and individuals are members of the association.

The f.o.b. port cost of chromite (1952/53) probably was TL 60 to TL 65 ($21.40 to $23.20) per metric ton, except for the large Güleman deposit, with a corresponding figure of perhaps TL 50 ($17.85). Of the total, mining accounted for TL 12 to TL 17.50 ($4.28 to $6.25), although in the case of Güleman it would be less. Inland transportation costs about TL 30 ($10.70) per metric ton; to this must be added about TL 5 and TL 7 ($1.78 to $2.50) for handling at the port. The remainder is covered by taxes, amortization, and overhead. Production and transportation costs have reportedly increased since 1953, and figures of TL 75 ($26.80) and higher have been given as the present costs of chromite landed at Turkish ports.

Consumption and Trade

Consumption of chromite in Turkey is negligible, and almost the entire output is available for export. Chromite exports by country of destination are tabulated in table 22. In 1956 private exports were 413,794 tons, compared with 228,215 for Eti Bank. The United States has been the largest single importer, and the status of the chrome industry in Turkey depends on United States imports. In 1954, when these purchases declined, many mines were obliged to close. As of November 1954, the Turkish Government reduced the state royalty on chrome exports from 5 percent to 1 percent of the f.o.b. sale price with a view to improving the competitive position of the Turkish industry. To sustain exports to the United States, barter arrangements have also

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been made involving the exchange of surplus agricultural commodities for Turkish chromite.

TABLE 21. - Chromite production, by areas, and main producers, 1954
(Metric tons)

District	Production	Main producers
Antalya	12,000	Tekirova Madenleri, Ltd., Şirketi.
Balikesir	200	Server Samancuoğlu.
Bursa	41,800	Fahrünnisa Ögelman.
		Server Samancuoğlu.
		Şakir Yorulmaz.
		Mineral Sanayi ve Ticaret T.A.O.
Burdur	7,900	Maadin Arama ve Işletme Limited Şirketi.
		Orhan Brand ve Şürekâsi.
		Başlangiç Ltd. Şirketi.
		Ramazan Gencer ve Hayri Yildiran.
Denizli	20,800	Montan Madencilik T.A.O.
		M. Ertuğrul ve Ortaklari.
		Yurt Maden Ltd. Şirketi.
Eskişehir	87,100	Orhan Brand ve Şürekâsi.
		Baştaş Türk Maadin Ltd. Şirketi.
		Mustafa Çakirözer.
		Türk Maadin Anonim Şirketi.
		Türk-Avrupa Ltd. Şirketi.
Elaziğ	134,000	Eti Bank.
Hatay	12,200	Bilgin Maden Ltd. Şirketi.
Kutahya	16,600	Hayri Ögelman Maden Işletmeleri.
		Cemal Erkartal.
Muğla	119,700	Stanley Patterson.
		Sitki Koçman.
		Fethiye Şirketi Madeniyesi T.A.Ş.
		Anadolu Maden T.A.Ş.
		Türk Maadin Anonim Şirketi.
Seyhan	32,800	Çanakçili Kardeşler.
Gaziantep	8,200	Do.
Bilecik	200	Muzafer Hançer.
Isparta	600	Çalikdağ Maden Işletmesi.
Kayseri	24,300	Özkrom Ltd. Ortakliği.
		Rasih Ihsan Limited Şirketi.
		Kemal Özdedeoğlu.
Nigde	16,000	Sabri Oncu.
Sivas	7,800	Arslan Tok.
		Necat Inan.
		Ayküz Kardeşler Krom Ltd. Şirketi.
Tokat	9,000	Tefvik ve Refik Beyoğlu Şirketi.

The sale of chromite is an important source of foreign exchange. The value of ore exported during the last few years has been as follows:

	TL	US$		TL	US$
1950	29,955,723	10,694,193	1954	43,455,816	15,513,726
1951	46,179,010	16,485,907	1955	55,622,516	19,857,238
1952	64,012,130	28,852,330	1956	65,140,750	23,264,554
1953	79,079,372	22,231,336			

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TABLE 22. - Chrome-ore exports from Turkey, by countries of destination, 1937-56
(Metric tons)

Source: Annual Foreign Trade Statistics, Turkey

Year	Austria	France	West Germany	Italy	Norway	Sweden	Switzerland	United Kingdom	United States	Other	Total
1937.....	5,029	19,899	58,383	4,772	8,061	45,889	-	1,016	45,632	9,779	198,459
1938.....	8,539	14,260	68,463	32,220	12,191	46,113	-	3,656	13,384	9,229	208,055
1939.....	-	18,825	104,156	15,736	17,122	-	15,680	-	19,438	1,885	192,842
1940.....	-	28,165	-	-	6,503	2,440	-	-	72,929	-	110,037
1941.....	-	-	-	-	-	-	-	-	86,208	-	86,208
1942.....	-	-	-	-	-	-	-	-	116,848	-	116,848
1943.....	-	-	-	-	-	13,564	-	25,973	41,251	40	80,828
1944.....	-	-	59,649	-	-	-	-	-	89,538	-	149,187
1945.....	-	-	-	-	-	3,320	-	-	59,362	-	62,682
1946.....	-	7,031	-	2,518	6,687	8,375	-	-	8,178	3,541	36,330
1947.....	3,395	32,632	-	7,925	25,580	44,650	-	4,449	65,146	-	183,777
1948.....	22,458	24,596	-	1,509	7,245	5,681	-	6,385	239,675	2,056	309,606
1949.....	37,324	17,676	8,196	5,750	500	16,280	50	11,018	252,610	3,842	353,246
1950.....	29,233	10,729	8,743	3,702	12,900	23,128	-	16,556	241,442	7,170	353,603
1951.....	35,472	27,288	38,828	6,140	7,774	12,821	2,595	15,959	356,246	1,486	504,609
1952.....	39,708	39,382	49,771	7,025	14,357	16,166	16,115	8,790	424,982	10,110	626,407
1953.....	38,687	19,452	27,391	2,666	21,618	22,147	8,219	15,834	514,377	8,066	678,457
1954.....	28,378	18,347	63,111	5,350	7,315	11,000	-	11,266	203,243	8,550	356,560
1955.....	32,515	24,926	65,689	4,606	-	2,000	-	22,919	393,731	13,197	559,583
1956.....	31,203	34,367	65,334	8,833	4,032	8,128	5,986	19,972	445,412	18,742	642,009

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Turkish chromite prices increased significantly in 1952 and 1953, but the trend was reversed in 1954. The following are average approximate prices (per metric ton) of base-grade chromite with 45 percent Cr_2O_3 f.o.b. Turkish ports: 1951, $31; 1952, $35; 1953, $40; 1954, $39; 1955, $33; and 1956, $32. Average f.o.b. prices 1956 for other than base grades were as follows: 48 percent Cr_2O_3, $35; 46 percent Cr_2O_3, $33; 44 percent Cr_2O_3, $32 and 40 percent, $27.

Average shipping costs, including loading and unloading at both ends, add $5 to $8.50 per ton. The price of Turkish chrome ore in 1953, f.o.b. United States Atlantic ports, was about $55 to $56 per long ton for 48 percent, 3:1 chrome-iron ratio. The corresponding 1954 average price was $45 to $48 and the 1955 price $50. Corresponding prices for 46 percent ore 3:1 ratio were $3 less.

The port of shipment for chromite ore depends on the location of the deposit. The following table gives the average transportation picture for the various mine groups:

Southwest Turkey. - Southwest Turkey is possibly the largest producing area. It has several accessible ports, such as Izmir, Marmaris, Fethiye, Antalya and Tekirova. Deposits are generally near ports.

Burdur-mine group	Ore from Burdur is trucked 215 km. via Burdur to Antalya port. Alternatively, ore is trucked an average of 150 km. west and north, mainly downhill, to the Izmir railroad and thence by rail (240 km.) to the port of Izmir.
Acipayam area	From Acipayam, ore goes 90 km. north over a dirt and gravel road to Denizli and from there either by rail to Izmir or by road (180 km.) to Muğla. Ore from Korkuteli goes SE. by road (140 km.) to Antalya.
Muğla-mine group	Ore goes by dirt and gravel road to Muğla or directly to the port of Marmaris. Average trucking distance is 50 km.
Fethiye-mine group	SW. 55 km. by dirt road to the port of Fethiye.
Tekirova area	SE. 9 km. to Tekirova.

Northwest Turkey. - The third largest producing area. The topography is rugged, with elevations from over 3,000 meters to sea level, but good roads and railroads are available to the ports of shipment - Izmit, Mudanya, and Bandirma.

Bursa-mine group	Bursa deposits lie south of the city of Bursa (1,200 meters altitude). Flow of ore is by road (average 60 km.) to Mudanya and by road and rail (average 320 km.) to Bandirma.
Kütahya area	Kütahya deposits (1,500 meters altitude) lie west of Kütahya. Flow of ore is northwest by rail to Bandirma.
Eskişehir-mine group	From mines in Eskişehir area (1,500 meters altitude) ore is trucked downhill to Eskişehir. Rail distance between there and Izmit port is 280 km.

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Southeast Turkey. - The area is the fourth largest producer. Generally, pay loads travel downhill to sea level from elevations as high as 2,000 meters in producing areas and 2,900 meters in potential areas. The main ports of shipment are Mersin and Iskenderun.

Maraş	Mines in Maraş area are 25 km. to the railroad and 234 km. by rail to Iskenderun.
Islahiye area	50 km. by rail to town of Islahiye, which is 93 km. by rail from Iskenderun.
Pozanti area	160 km. to Adana and another 120 km. by rail from Adana to Mersin.
Iskenderun area	80 km. to Iskenderun.
Mersin area	65 km. average distance to Mersin.

East Turkey. - The second largest producer, but farthest from ports.

Güleman and Sori Dağ	Ore is brought by 60-cm.-gage rail in the case of Güleman and by truck in the case of Sori Dağ to an aerial tram, which carries it 18 km. to Erganimaden railroad station. From there to Iskenderun is 543 km. Ore from vicinity of Palu mine (2,000 meters) is trucked about 50 km. to Palu (1,000 meters). Palu Iskenderun by rail is 590 km.
Sivas	Average distance from potential areas (1,980 meters) to Sivas (1,280 meters) is 50 km. over gravel roads and trails. Sivas to Samsun is 404 km. and to Mersin 567 km. by rail.
Bitlis	Average distance from potential producing area (elevation up to 2,750 meters) to Bitlis (1,400 meters) is 80 km. and to Siirt (930 meters) 100 km. over dirt roads. Bitlis to Tatvan railhead is 26 km. by gravel road. Tatvan to Iskenderun is 790 km. From Siirt to Kurtalan railhead is 30 km. and from Kurtalan to Iskenderun is 784 km.

North Turkey. -

Kastamonu area	Ore is transported over gravel and macadam roads 80 km. to Inebolu on the Black sea, descending from an elevation of 1,990 meters to sea level.

Exports in 1952 from the various ports rounded figures and 1956 deliveries to ports were as follows in metric tons:

Port	1952	1956	Port	1952	1956
Iskenderun.....	209,000	286,715	Izmir (Alancak).....	36,000	32,217
Fethiye.....	128,000	116,414	Mersin.....	25,000	80,558
Izmit.....	54,000	54,842	Derince.....	23,000	5,067
Marmaris.....	-	38,602	Inebolu.....	8,800	-
Bandirma.....	50,000	32,454	Samsun.....	4,000	5,499
Antalya.....	44,000	15,525	Other.....	1,200	4,572
Mudanya.....	43,000	10,795			

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Nature and Location of Deposits

All chromite deposits in Turkey are associated with ultrabasic rocks (fresh peridotite and serpentine) and have been formed by differentiation of the peridotite magma (42). Besides true crystal differentiation, there are vein forms that originated by intrusion of the ore magma into the already congealed part of the intrusive body. The deposits show great variety in size, form, and composition. The wide range in the period of cooling and injection of the peridotite magma and the post-magmatic tectonic movements account for the differences mentioned above. The following are some of the types of chromite deposits found in Turkey.

Banded Ore. - Steeply dipping planar schlieren (represented by Çatak, Topuk, and Çöreler) consist of alternate chromite-rich and olivine-rich bands of varying thickness formed perhaps as a result of flow structure in a steeply rising magma. Flat-dipping or horizontal planar schlieren (as in Kütahiya) are widespread and consist of disseminated or massive banded ore.

Segregated Ore. - Irregularly formed pods or sacks of disseminated ore, formed through action of gravity and flow motion, fading into sterile rocks. This type is represented by Basören.

Massive Ore. - Lenticular veins of massive chromite in fresh peridotite, showing swelling or pinching in width but with considerable strike length, are represented by the chromite deposits of Sori Dağ. Massive ore is also found in tectonically moved deposits, as in Kundikan and Gölalan. Lens-shaped bodies of ore of different sizes are bedded in highly sheared fish-scale-like serpentine. The deposits are surrounded with gliding planes carrying talc or magnesite and have undergone late tectonic movements after country rock and ore solidified.

Injection Stocks (Kavak). - Late intrusion of a rich chromite residual magma in a peridotite magma already partly or fully solidified. The ore is disseminated or ovoid.

Some 180 occurrences of serpentine and peridotite have been reported in Turkey, and over 150 individual chromite deposits have been discovered in 35 different districts. For the sake of convenience, these ore-bearing areas have been classified by Ils and described in table 23 (42 and others) and shown in the map, figure 19. A view of the Gölalan ore body is shown in figure 20.

The ore is generally high-grade metallurgical chromite averaging 48 percent Cr_2O_3. Information on ore reserves is inadequate and inaccurate; however, reserves may amount to 3,000,000 to 4,000,000 tons. Reserve figures for individual deposits in table 23 must be considered only as indicative of probable and possible sizes of the ore body, because, in tonnage calculations, the depth of the ore body often is estimated rather than measured. In few instances has the necessary exploration and development work been done to block out reserves.

In view of the large number of occurrences of peridotites and serpentine in Turkey, occupying an area of 9,000 square miles, and because many deposits lead to others below, the outlook for further discoveries is considered favorable, especially if a tool could be found whereby buried deposits could be discovered. The Eti Bank has been conducting geophysical work in the Güleman area.

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TABLE 23. - Chromite deposits in Turkey

Province (1) County Name	Description	Mining and processing	Remarks
		NORTHWEST	
Eskişehir	Ore deposits of Eskişehir area occur on crest and south flank of Taştepe mountain Range which has an east-west alinement and lies 25 km. north of Ankara-Istanbul railway. Taştepe Range which reaches a maximum elevation of 1,580 m. above sea level is composed of serpentine in contact with Paleozoic schists on the west and rocks of Oligocene age in the southeast. Chromite bodies are found as steeply dipping veins and as a series of flatly dipping lenses with an east-west alinement. Disseminated bodies are magmatic segregations injected into fissures along fault lines. Massive ore bodies are intrusive veins with sharply defined contact with serpentine. They vary in shape and size depending on structural features of enclosing serpentine.	In 1952, 12 operators worked 22 properties in Eskişehir Province.	
Mihalıççık: Kavak, 15 km. NE. of Mihalıççık	3 massive lodes of conical shapes with their apex upward in an area of about 1 km. N.-S. and 300 m. E.-W. Ore depth is 80 to 120 m. Country rock is dunite altered to serpentine. Chromite is speckled, striated, or compact, containing 38-40 percent Cr_2O_3.	Entry into mine is by 2 shafts, each about 60 m. deep. Ore is won by cut-and-fill stoping and concentrated by Humphreys spirals to a product carrying 47 percent Cr_2O_3, 5 percent SiO_2 and 13 percent FeO. Equipment at mine consists of 210-hp. diesel engine, electrical equipment, hoist, and trucks.	Reserves (1950): Measured and indicated: 300,000 metric tons. Transportation: 24 km. to nearest R.R. station. Ore transported to station by 12 km. aerial tramway and truck and thence 330 km. by rail to Izmit. Production: 1952: 52,825 metric tons. Ownership: Türk Maadin Anonim Şirketi.
Bahtiyar	Country rock is serpentine, more or less intensely altered, surrounded by shales and impure limestone. Ore occurs as (1) irregular lenses and (2) nonpersistent narrow bands of chromite in areas of relatively widespread disseminated chromite. There has been little production from disseminated ore areas. Ore analysis: Cr_2O_3, 35-47 percent.	About 80 percent of run-of-mine ore must be concentrated.	Reserves: 150,000 metric tons, 35 to 40 percent Cr_2O_3; 400,000 metric tons, 30 to 35 percent Cr_2O_3. Transportation: Truck transportation on 24 km. dirt road to R. R. station, 312 km. from Izmit. Production: About 900 metric tons yearly. Ownership: Şakir Yorulmaz.
Eskişehir: Başören and Lacin	Ore in Başören mine occurs in round to vertically flattened lenses in serpentine. 4 lenses strike NW-SE and reach a depth of 45 m. below surface. Lacin mine is vein-type, with chromite band 50 cm. to 2.5 m. wide. Ore analysis: Cr_2O_3, 44 percent.	Underground open stoping. Ore upgraded by hand cobbing. 17-kw. generator is installed at Başören mine. Approximate annual production, 9,000 metric tons.	Reserves: Indicated: 50,000 metric tons. Transportation: Truck transportation 24 km. on dirt road to Alpiköy R. R. station. Distance from Alpiköy to seaport of Derince (Sea of Marmara), 270 km. Production: 1952: 36,640 (Başören); 6,218 (Lacin). Ownership: Orhan Brand ve Şurekasi Ltd.
Taştepe	Typical lens formation, with lenses alined in NW-SE direction over a distance of 600 m. Individual lenses are small, 200 tons or more. Ore analysis: Cr_2O_3 46-47 percent.	Entry into mine is by a shaft. Mine equipment consists of a compressor driven by a 25-hp. diesel engine, shaft hoist (6 hp.), jackhammers, hoists, narrow-gage tracks, and side-dump cars.	Reserve: 10,000 metric tons. Transportation: Truck transportation on dirt road for 33 km. and then by rail 270 km. to Izmit. Production: 1952: 7,657 metric tons. Ownership: Baştaş Türk Maadin Limited Şirketi.
Bursa: Orhaneli	In area Çatak-Topuk-Çöreler a number of mines on E. and W. sides of the Orhaneli-Bursa road between Değirmen and Çatak are worked. The deposits are tabular, banded, and generally steep, occur in dunite as in Yildirim, Hal Dede, Selcuk, Kalayci kiri, Ortadere,		Transportation: Truck transportation, 80 km. to port of Mudanya.

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	Tepekoyü, Sari alani and Çöreler. In these mines ore bodies consist of alternating chromite-rich and olivine-rich bands that strike parallel in a northerly direction. In addition, there are veins in dunite (Haci Ömer and Piraslik) and in serpentine (Geyik alani, Kaya and Deve Yolu).		
Yildirim	Deposit 2-10 m. thick, 70 m. long, and 40 m. deep dipping 85° W. and striking N.-S.	Ore must be hand-sorted.	
Haldede and Selcuk	Mines are a short distance N., and along strike of Yildirim deposit.		
Sülüklük	Short distance E. of Yildirim, with same strike and dip.		
Orta dere	Tabular ore body 13 m. thick. Chromite content is low.	Mined opencast.	
Kalayci kiri	Tabular ore body striking N. 10° E., short distance south of Çatak köyü.	Hand-sorted ore carries 35-40 percent Cr_2O_3.	
Sari alani	Short distance E. of Çatak köyü. N.-S. strike, steep dip W., 2.5 meters thick.		
Çöreler group	A number of mines N. and W. of Çöreler. The deposits strike generally N. and dip W. (60° and steeper), are 2.5-3.0 m. thick and 15 to 110 m. long. Alternate bands of chromite and olivine constitute some ore bodies.	Hand-sorted ore analyzes 41-43 percent Cr_2O_3.	
Piraslik and Haci Ömer	Piraslik is 13 m. long bed, E.-W. strike with 40° S. dip. Haci Ömer is similar, with 0.3-1.0 m. thickness.		
Geyik alani	Number of chromite lenses arranged in line striking E.-W. in serpentine.	Cr_2O_3 content, 50-52 percent.	
Deve Yolu	A steeply dipping deposit in serpentine. Due to crossfaulting, ore is of a broken nature.	Hand cobbed ore carries about 48 percent Cr_2O_3.	
Çöreler	2 parallel, steeply dipping ore bodies in serpentine, nearly 800 m. long. In places 2 ore bodies combine resulting in thicknesses up to 20 m. in favorable locations.		
Hermancik	Probably a vein deposit in dunite; thickness of vein varies 0-2 m. and length 1 km. Present underground workings are 60 m. below surface. Ore analysis: Cr_2O_3, 46-50 percent.	Cut-and-fill stoping using mainly hand tools.	Transportation: 28 km. to R. R. station and 240 km. to Bandirma. Ownership: Hayri Ogelman Maden Işletmeleri.
Kütahya; Simav County; Dağardi	Deposits are located W. of Kütahya at elevations of nearly 1,500 m. Dağardi mine is found in 1 of largest chromite massifs (Bursa-Balikesir-Kütahya) of Turkey. Ore bodies were pipe shaped - largest one had a horizontal length of 750 m., and a depth of 340 m. Chromite was massive.	Operations in this Province began about 1900 in Dağardi mine, which produced 800,000 tons of ore before its shutdown in 1940's. Dağardi was reopened in 1951 and has produced minor quantities of ore. In 1952 12 operators worked 17 properties in this county.	Transportation: Ore transported northwest by rail to port of Bandirma. Production: 1952: 7,500 metric tons. Ownership: Kemal Er Kartal.
Tavşanli County:			
Kargili			Production: 1952: 1,800 metric tons. Ownership: Maadin Arama ve Işletme Limited Şirketi.
Derbent			
Kişlademirlisi			Production: 1952: 1,244 metric tons. Ownership: Ahmet Turhan.
Dümrek			

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TABLE 23. - Chromite deposits in Turkey (Con.)

Province (İl) County Name	Description	Mining and processing	Remarks
		SOUTHWEST	
Burdur:	Distribution of chrome ore in Burdur is somewhat erratic but generally follows N.-S. line. Most occurrences are veinlike (0.6-4.0 m.) and make sharp contact with the surrounding wall. Ore is generally friable.	In 1952 8 operators worked 11 properties in Burdur Province.	
Yeşilova and Tefenni Counties:			
Comuzdami Gökarik Yeşilova Topusden mines and others between cities of Tefenni and Yeşilova	Country rock is serpentine. 2 types of deposits comprise disseminated ore bodies outcropping intermittently and lenses found intermittently along a line of mineralization determined by massive outcrops. It is believed that disseminated ore bodies may lead to large bodies of compact ore. Ore analysis: Yeşilova-Cr_2O_3 40 percent and Gökarik-Cr_2O_3 47 percent.	Ore won in opencut and adit mines. Hand cobbing is necessary to bring run-of-mine ore to 48 percent Cr_2O_3. Gökarik mine has 400 $m.^2$ of working face, but this is not typical.	Reserves: Indicated: 200,000 metric tons. Transportation: Truck transportation, 215 km. to Antalya via Burdur. Shorter road (145 km.) through Tefenni and Korkuteli can be used only in good weather. Production: Yearly: 30,000 metric tons (average). Ownership: Maadin Arama ve Işletme Limited Şirketi.
Müslimler (near Burdur)	Ore analysis: Cr_2O_3, 46 percent.	Mines lack equipment; ore probably is mined by handtools.	Production: Yearly: 500 metric tons. Ownership: Hayri ve Selahattin Ogelman.
Denizli:			
Acipayam County:			
Mevlutlar Karaismailler	5 steep, parallel chromite veins in harzburgite striking NE.-SW. and dipping westwards. Veins have been followed 600 m. and occur in a width of 100 m. Average ore analysis: Cr_2O_3, 46 percent. Chromite is either massive or spotted.	In 1952 two operators worked 3 properties, 1 at Mevlutlar and 2 at Karaismailler.	Reserves (1953): 100,000 metric tons. Transportation: Mines are 70 km. from Izmir-Aydin railroad. Rail distance to Izmir is 240 km. Production: Yearly: 30,000 metric tons (average). Ownership: Montan Madencilik T.A.O.
Muğla:			
Köyceğiz County:			
Karagaac	Ore analysis, Cr_2O_3, 44 percent.	In 1953, significant quantities of ore were produced at this mine.	Reserves: 30,000 metric tons. Transportation: Truck transportation 15 km. to port of Karagaac. Production: Yearly: 10,000 metric tons (average). Ownership: Türk Krom Anonim Şirketi.
Kuzkavak, 22 kilometers from Göcek	Along a 1,000-meter line, N. 30° E., are 5 mines at altitude of 840 m.: Dere ocak, Koca ocak, Kum ocak, Kir ocaklari and Birinci ocak. Of these Koca ocak is largest; in this mine lenticular ore is intergrown with peridotite. Ore is rich, Cr_2O_3 54 percent, Fr:Fe is 3.4:1.	Koca ocak and Dere ocak are worked from adits and Kum ocak in an open pit.	Ownership: Anadolu Maden T.A.Ş.
Çatal, Yemişli, Sakar, Sulu, Yol, Kizil dere, and Kumbuk	This group of mines is 3 km. E. of Kuzkavak at altitude of 900 m.; occur as lenses of massive chromite in harzburgite. Quality of ore is similar to Kuzkavak group. Sulu is principal mine; it measures about 40 m. along strike and is 1.5 to 5 m. thick. Cr_2O_3, 48 percent.	Sulu ocak; is mined underground by adits and winzes.	Reserves (Sulu): 12,000 metric tons. Transportation: Sulu ocak mine is 22 km. NE. of Köcek port over steep, winding road. Ore is transported to this port by truck. Production: Average yearly, 6,000 metric tons. Ownership: Türk Maadin Anonim Şirketi.

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Sandalbaşi in Elcik village, 40 km. W. of Köcek	In Sandalbaşi 3 steep ore bodies (pipes) 10-20 m. long in horizontal section occur in serpentinezed harzburgite. Cross faulting cut ore body, resulting in a large percentage of fine ore. Ore analysis: Cr_2O_3, 46 percent.	Ore is upgraded in a small concentrator.	Production: Yearly: 3,000-5,000 metric tons. Ownership: Stanley Patterson.
Bulüslü in Bezkese village, 10 km. SW. of Sandalbaşi	A new massive ore body was found by following fault cutting old deposit outcropping at surface. New ore body is large: 110 m. along strike with thickness up to 110 m.; axis has been followed for over 200 m.		
Çayhisar Zeytin ocak	Foothills of Sandras Mountains. Geology is similar to Otmanlar. Ore analysis: Cr_2O_3, 50-51 percent.	Entry to mine is by adit. Mine is worked by hand method, except for a 10-hp., electrically driven hoist for winze, power being generated by a small diesel engine.	Reserves: Indicated: 4,000 metric tons. Transportation: Mine is connected with shipping port of Köcek by a rough truck road 65 km. long. Ownership: Türk Maadin Anonim Şirketi.
Near Otmanlar Bavetcik Gökgedik Yarpuz Karacik Mesebükü	Chrome ore bodies are entirely within serpentine, which has been intruded into Paleozoic limestones. Ore bodies take form of irregular lenses, masses, and veinlike structures, and placers. Mesebükü is eluvial placer. Chromite pieces and sand ore mixed with serpentine occur on steep bank of Mesebükü. In Karacik an area nearly 5,000 m. underlain by serpentine is strewn with free-lying chromite. A few blocks are $2m.^3$, but others are smaller.	Prospecting of these deposits begun about 1950.	Reserves: Indicated: Over 100,000 metric tons. Transportation: Mine elevations, 1,000 to 1,300 m. It was planned in 1950 to construct 80-km. roads from deposits to port of Ekincik on the Mediterranean. Ownership: Türk Maadin Anonim Şirketi.
Fethiye County:			
Kargi-foça Cenger Üzümlü Domuzalani Demirkazik Inbaşi Mezarlik and others	Ore occurs in harzburgite in 2 groups of elongated lenticular bodies from a few cm. to 5 m. thick. Length of ore bodies reaches 100 m. to 300 m. in many places, and depth is up to 120 m. 80 percent of ore is nodular and disseminated ore and remainder massive. In nodular ore appear well-rounded masses of chrome 5 to 15 cm. in diameter, with serpentinized cementing material. In disseminated ore this chromite is of irregular shape. Ore analysis: Nodular and disseminated ore: Cr_2O_3, 45 to 54 percent.	Ore mined underground by overhand cut-and-fill stoping. Washery with capacity of 7 tons per hour concentrates nodular and disseminated ore to 50-52 percent Cr_2O_3. Power is supplied by 300-hp. steam engine. Mines also have steam-driven compressors, steam hoists, locomotives, and 6-ton mine cars.	Reserves: 100,000 metric tons. Transportation: Ore moves on narrow-gage railroad, 19 km. long, or on a dirt road (about 55 km.) to port of Fethiye. Production: Yearly: 15,000 metric tons (average). Ownership: Fethiye Şirketi Madeniyesi.
Toparlar Sultaniye	Mining area is in serpentine overlain by limestone.		
Antalya: Tekirova	Mine is at Ces. Company has old water concentrating plant.		Production: Yearly, 13,500 metric tons. Ownership: Tekirova Madenleri Limited Şirketi.
		SOUTHEAST	
Maraş: Maraş County: Near Maraş	Several deposits producing metallurgical chromite.	Exploration of deposits began in 1949.	Reserves: Measured: 20,000 metric tons. Indicated: 45,000 metric tons. Transportation: Ore hauled to Narli R. R. station, an average of 8 km., by truck. At Narli ore is hand-loaded into railroad cars for shipment to Iskenderun, 210 km. distant. Production: 7,000 to 8,000 metric tons (average). Ownership: Bilgin Maden Limited Şirketi.

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TABLE 23. - Chromite deposits in Turkey (Con.)

Province (1-1) County Name	Description	Mining and processing	Remarks
		SOUTHEAST (Con.)	
Gazizntep: Islahiye County: Islahiye	Metallurgical ore is obtained from small ore bodies scattered over a fairly large area.	This firm obtained 45 concessions covering area of 910 hectares in this district.	Transportation: Port of shipment is Iskenderun, 170 km. from R.R. stations of Kümürler and Islahiye. Production: Yearly: 8,000 metric tons (average). Ownership: Islahiye Krom Madenleri.
Hatay: Iskenderun County: Kirli mine	Kirli ore is refractory (Cr_2O_3, 38 to 40 percent, SiO_2 5-6.5 percent, Al_2O_3 22-23 percent, FeO 14-15 percent, CaO 1 percent) found in serpentinized peridotites, usually as pipes, lenses, and irregular veins.	Underground mining by hand labor. Mine is equipped with light rails and 1-ton cars.	Reserves: Measured: 90,000 metric tons. Indicated: 140,000 metric tons. Transportation: Mine is 35 km. S. of Iskenderun; ore hauled to this port by trucks. Production: Yearly, 6,000 metric tons (average). Ownership: Bilgin Maden Limited Şirketi.
Seyhan: Karaisali County: Pozanti, Findikli, Hamidiye, Tamrut, Karakuz, Sofulu, Gerdağ, etc.	Individual chromite lenses, with high-grade compact ore (50-51 percent Cr_2O_3) occur in serpentine. Lenses are located relatively far from each other, and mountainous topography makes transportation difficult. Each lens is relatively small (25 to 50 meters long and 5 to 7 meters maximum width).	Pozanti area developed in 1951. Nine deposits worked produce lump metallurgical ore.	Reserves: Measured: 75,000 metric tons. Indicated: 200,000 metric tons. Transportation: Ore from Pozanti moves 160 km. to Adana and 120 km. by rail to Mersin.
Icel: Mersin			Reserves: 10,000 metric tons. Ownership: Osman Ilhami Keskinkilic.
		EAST TURKEY	
Elaziğ: Maden: Güleman	Favorable chromite area is 35 km. long by 10 to 12 km. wide. Deposits occur as veins in peridotite or pyroxenite, as lenses in dunite and serpentine, or as dissemination near contact zones. 15 known deposits are in a general alinement, although variations occur. These are:	All deposits are worked opencast. Drilling is with compressed air.	Reserves: Measured: 700,000 metric tons. Transportation: Aerial ropeway with 125,000-ton annual capacity carries ore to Maden R.R. station, whence it is shipped 543 km. to port of Iskenderun. Production: 1956, 267,870 tons plus 24,610 tons of low grade material of which 7,908 tons fed to concentration to produce 4,570 tons of concentrate. Ownership: Eti Bank.
	Güleman group: Gölalan, Tosin, Şimal, Saysin.		1956 production, 134,603 tons.
	Kündikan, NW. of Guleman: Several small pockets.		
	Sori Dağ group NW. of Kündikan: Kefdağ, Kapin, Yunus Yayla, AyiDamari, Uzun Damar, Tepebaşi RutDağ, Mermek		1956 production, 133,267 tons.
	Northeast of Güleman: Bağin, Herbit Yayla		

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	Güleman - Since 15 years largest producer of chromite. Ore bodies occur in serpentine, which shows schistosity. Limit of ore body with country rock is marked with slickenside. Ore is hard and lumpy and carries 50-52 percent Cr_2O_3. Kündikan - Small chromite bodies of compact chromite, 300-450 tons each, in antigorite serpentine usually occurring in a row. Ore bodies have undergone tectonic movements and are limited by planes of movement. Cr_2O_3 52-54 percent. Sori Dağ: A number of veins - Uzun Damar, Ayi Damari, Yunes Yayla, Yunus deresi, and Tepe başi occur as chromite segregation in fresh peridotite. The veins are lense shaped. Uzun Damar is 1200 m. long with thickness increasing to 3 m. in places but ordinarily much less. Ayi Damari is parallel to Uzun Damar, 1000 m. long. Yunus Yayla and its continuation Yunus deresi is 100 m. long and 2 to 3 m. thick. These veins generally strike N.-S. and dip W. Kefdağ and Kapin - Tabular deposits in serpentine. Kefdağ strikes E.-W., is several hundred m. long and averages 4 m. wide. Ore varies from speckled to compact types. Kapin consists of 2 parallel deposits at 70 m. distance, each 1-6 m. thick and about 500 m. long (including interruptions). Cr_2O_3, 43 percent.	From main ore body, ore is hauled 2 kilometers by diesel locomotives over a 2-km. 60-cm.-gage track to aerial ropeway bins (6,000-ton capacity). Equipment consists of portable compressors, mine locomotives, etc. Ore from Sori Dağ group of mines is trucked to aerial ropeway bin.	Mine altitude, 1,800 m.
Palu County: Genefi Mahman			Annual production: Genefi, 5,000 metric tons. Mahman, 3,000 metric tons. Ownership: Bilgin Maden Limited Şirketi.
	NORTHERN TURKEY		
Kastamonu: North of Kastamanu	Area covers scattered occurrences of serpentine.	New district that started production in 1951 (1,100 tons).	Reserves: Indicated: 70,000 metric tons. Transportation: Ore flows N. over gravel and macadam roads 80 km. to Inebolu on Black Sea, descending from a maximum elevation of 2,000 m. to sea level.

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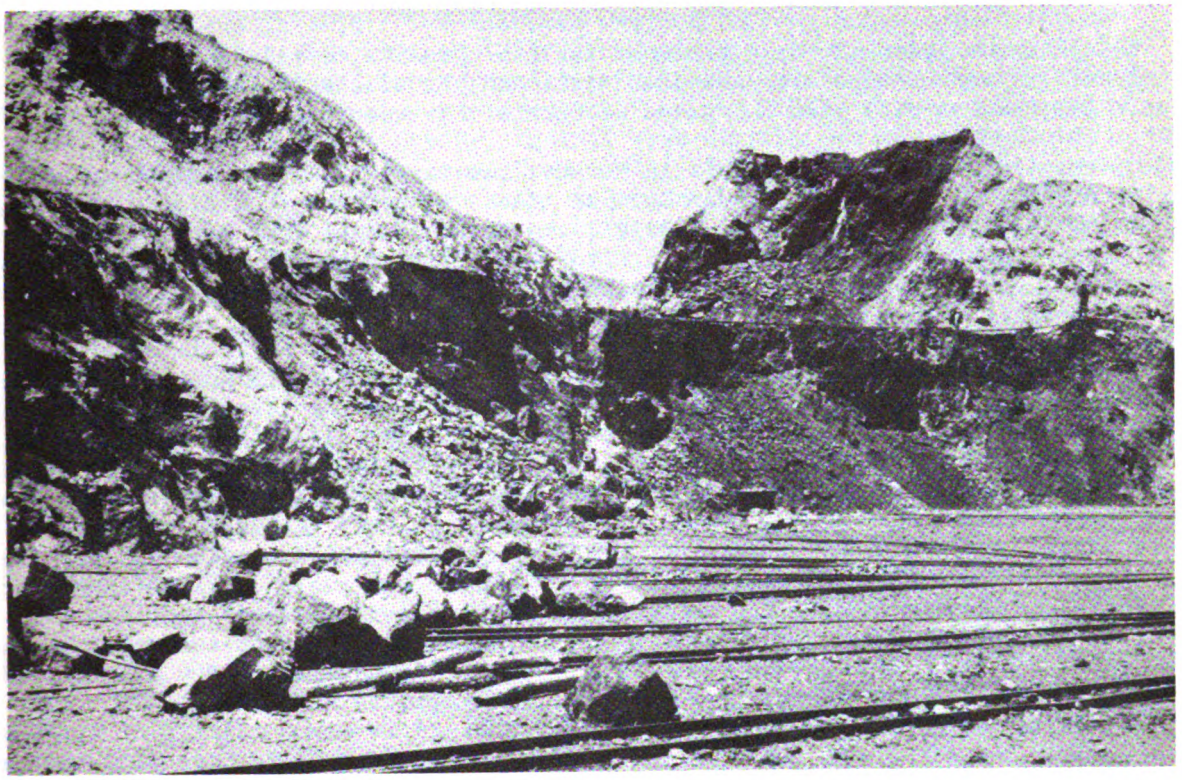

FIGURE 20. - View of Gölalan Ore Body, Güleman Chromite Mines.

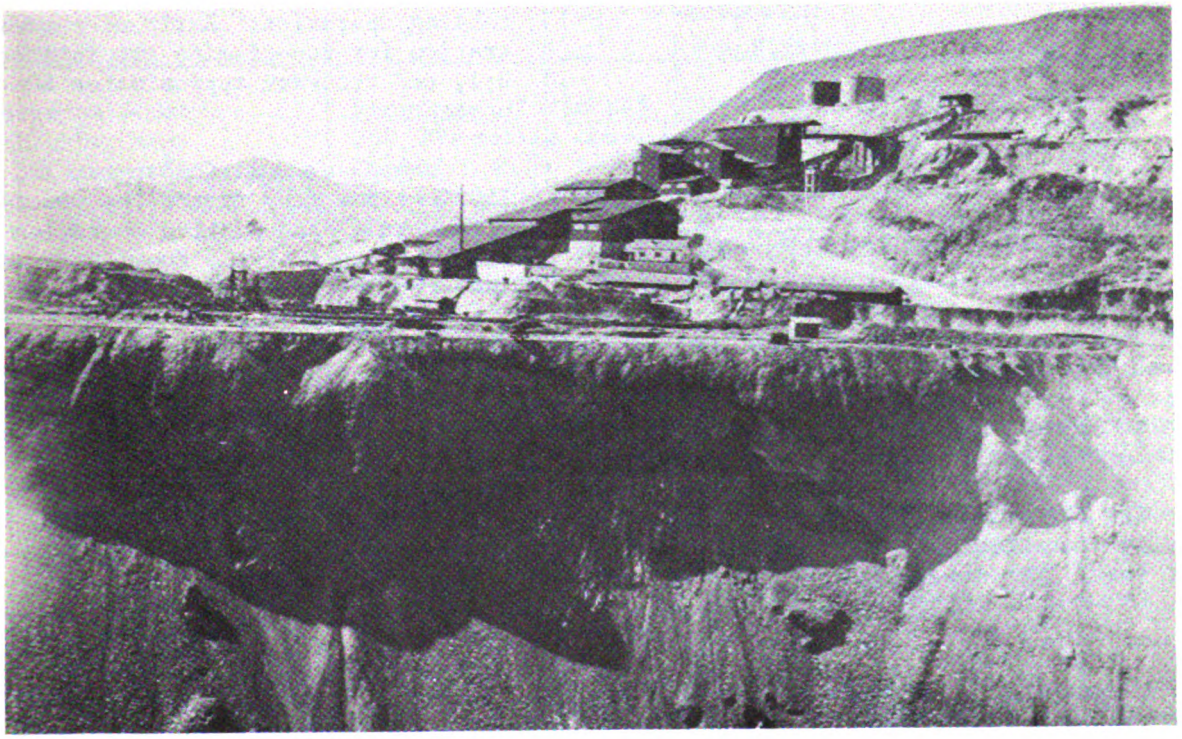

FIGURE 21. - Güleman Chromite Concentrator.

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Chromite-Concentrating Plants

Owing to the generally high grade of Turkish chromite, a relatively small percentage of the run-of-mine ore undergoes mechanical beneficiation before it is marketed. However, at each mine the grade of ore is increased by hand cobbing.

Of the 4 chromite concentrators in Turkey, the largest - with a capacity of 240 metric tons per 24 hours - is at the Güleman mine. Others are at the mine of Fethiye Şirketi Madeniyesi in the Fethiye district, the Kavak mine of Türk Maden Şirketi, and the Tekirova mine of Tekirova Madenleri, Ltd., Şirketi. Generally the plants consist of crushers, tables, and jigs. Run-of-mine ore is concentrated on a 2:1 ratio up to 48 to 50 percent Cr_2O_3, with 75- to 80-percent recovery.

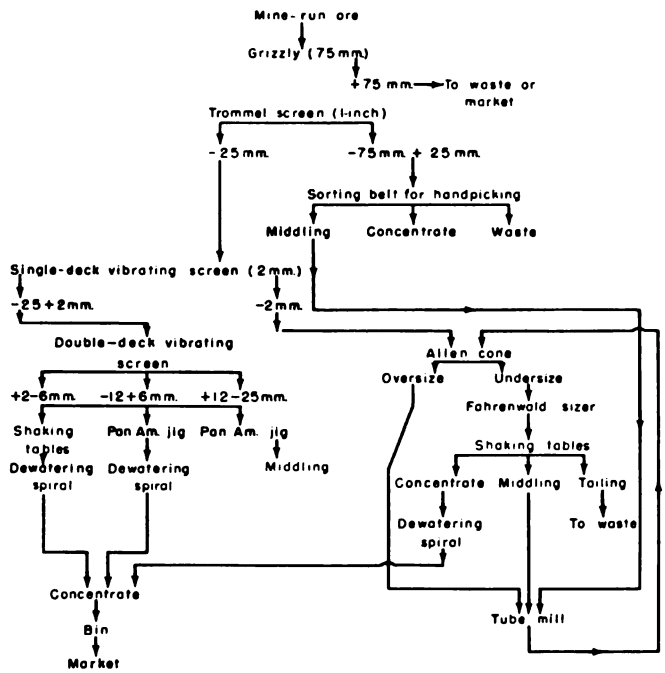

FIGURE 22. - Flowsheet of Güleman Chromite Concentrating Mill, Turkey.

A view of the Güleman concentrator and the flowsheet are shown as figures 21 and 22, respectively. It consists of picking belt, jigs, tables, and Fahrenwald sizers. The mill is well designed and produces a clean concentrate. In 1953 the feed consisted mainly of fines accumulated from previous years. In 1956 the plant treated 7,908 tons of low-grade material and produced 4,570 tons of concentrate.

Milling at Fethiye (120-ton capacity per 16 hours for run-of-mine ore and 160 tons per 16 hours for old tailing) is a crushing, jigging, and tabling operation. Ratio of concentration for run-of-mine ore is about 2:1, and recovery approximates 80 percent.

The Kavak mill (capacity, 120 to 150 tons per day) treats the undersize from a hand-picking operation, which is successively comminuted in jaw crusher and rolls. The product is divided into a minus-0.6-mm. undersize, which goes to a classifier, Humphreys spirals, and a Wilfley table, all in closed circuit; and a 0.6- to 1.2-mm. oversize, which goes over pneumatic tables. The ratio of concentration is 1.54:1, and recovery is 85 to 90 percent. Concentrates from the Humphreys spirals and pneumatic tables carry, respectively, 53 to 54 percent Cr_2O_3 and 51 to 52 percent from 42-percent Cr_2O_3 feeds.

The Tekirova mill is small, with a capacity of 20 to 30 tons per day, using gravity concentration to produce a 49-percent Cr_2O_3 concentrate from 25- to 30-percent feed. The concentration ratio is 2.9:1 and recovery 75 to 80 percent.

Manganese

Production of manganese ore increased from 2,370 metric tons in 1946 to a maximum of 89,846 metric tons in 1953 but declined to about 50,000 tons per year in 1954 and

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1955 and 58,407 tons in 1956. The increase was due to continuous demand and the high prices prevailing from 1950 to 1953. Production comes mainly from mines between Bolu and Zonguldak and around Denizli, Gaziantep and Ereğli. Consumption in Turkey is small, so most of the ore is exported to the United States and various western European consuming countries; in 1956 West Germany was the largest importer, followed by France. Production comes from small, dispersed deposits; therefore, the competitive position of Turkish manganese is not strong when prices and market are not as favorable as they have been in recent years. The production cost of manganese ore at the mine varies from TL 9 to TL 13 ($3.20 to $4.65), whereas average trucking and railroad costs from mine to port may be TL 25 ($8.90).

Little information is available on the size, reserves, and extent of individual mines. Source 44 gives a total of 122 deposits. Usually the mines are small surface workings, operated without mechanical equipment. Considerable hand cobbing and sorting are required before a marketable grade is produced; in some instances only 10 percent of the mined ore is marketable. The deposits are along the Black Sea and Aegean coasts and in Anatolia (see table 24). Important outcroppings of manganese ore in calcareous, marly or siliceous sediments, usually associated with andesites, border the Black Sea. These deposits generally are not too far from one of the Black Sea loading ports, such as Findikli, Rize, Trabzon, and Ordu. The Aegean Sea deposits are mainly in the Edremit area and of poor grade. In the Denizli area several manganese mines are operated in the vicinity of the mining towns of Tavas and Acipayam, both of which are connected by good road to Denizli, from where ore is railed to Izmir. The Ulukoy mine is believed to be the largest property. Mines are worked in Kalecik and Keskin areas of Ankara Il for the Karabük steel plant.

TABLE 24. - Manganese deposits in Turkey

Province (Il) County Name	Description
Denizli:	
Acipayam County: Ulukoy, near village of Ulukoy	Reserves: Indicated, 100,000 metric tons; inferred, 500,000 metric tons. Geology: 0.50- to 2.50-m. Mn bed occurs between a shaly limestone footwall and limestone hanging wall. It strikes E.-W. and dips about 70° SW. Folding and faulting have taken place. Ore is mixed with limonite in some places, and hand sorting is necessary. As shipped, ore has 46 percent or better Mn, about 4.5 percent Fe, and 4 percent SiO_2. Mining: Ore is won mainly from adits driven from outcrops by pick and shovel; 36,822 tons was produced in 1952 and 12,939 in 1954. Transportation: Property is connected by 7-km. dirt road to a State highway. From this road junction to Denizli is 65 km. Rail distance Denizli-Izmir, is 260 km. Transportation cost, road and rail, estimated (1953) at TL 25 per metric ton.
Doğdu Mevkisi near Baharlar	Manganese pieces up to fist-size are strewn on several square km.
Ankara:	
Kalecik County	Deposit of 10,000 tons (37.3 percent Mn, 30.10 percent SiO_2, 0.70 percent pyrolusite) near Tilkekoy. Deposit of 50,000 tons (23.25 percent Mn, 56.5 percent SiO_2, 1.18 percent Fe) near Aktepe.

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TABLE 24. - Manganese deposits in Turkey (Con.)

Province (Il) County Name	Description
Ankara (Con.): Keskin County: Göztepe	Ownership: Tevhit Kutay ve Hulûsi Kurtuluş. Geology: Mn ore beds occur in a country rock of tuffite or andesitic rocks formed from volcanic rocks existing in the area. Observed strikes vary from N. 40° E. to N. 60° E., and thickness in 3 pits was, respectively, 1 meter, 3 meters, and 6 meters. Analysis: Mn, 38-40 percent, SiO_2, 8-10 percent. Mining: Mine is worked in 5 open pits 25 km. east of Keskin; it has been operated since 1949 and has been main ore supplier to Karabük steel plant. In 1954 it produced 7,095 tons of marketable ore. Transportation: A poor road, 24 km. long, connects village of Göztepe to Keskin. Latter is 28 km., by a good road, from Kirikkale R.R. station on Ankara-Kayseri Railroad.
Bursa: Orhaneli County	Deposit of probably 5,600 tons of 44.7 percent Mn in Orhankebir township; 2 undersized deposits near Kinik and Karalar.
	Black Sea coast
Artvin: Hopa County: Abu Hemşin	Geology: Mineralization has taken place in a fault zone at contact of andesite tuffs and andesite. There are pods of ore, each several hundred tons in size. Ore mainly pyrolusite and braunite. Analysis of Sorted Ores: Mn 47-49 percent; SiO_2 7-9 percent; Fe, 3-4.5 percent; P, 0.02 percent. Transportation: Mine is 300 meters above Hemşin village and connected to it by a 2.5-km. trail. Hemşin village is 10.5 km. by a poor truck road from Findikli port. Production: Mine reportedly produced about 4,000 tons of ore in 1949. Status unknown.
Findikli County: Piskala	Ownership: Rasih Ihsan Kollektif Co. Mine is on Piskala River near Findikli. Ore similar to Abu Hemşin.
Borçka County	A deposit of probably 10,000 tons assaying 29.1 percent Mn at Tütüncüler.
Rize: Ardeşen County: Yanivat	Mine, owned by Yanivat Manganez Maden Işletmesi, produced 720 tons in 1954.
Trabzon: Sürmene County	Sürmene mine (near Pirgi) has pyrolusite of following composition: Mn, 51 percent; Fe, 3 percent; SiO_2, less than 5 percent; P, 0.06-0.12 percent; traces of Cu, Pb, and As. Production rate during 1949-50, 1,500 metric tons per year.

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TABLE 24. - Manganese deposits in Turkey (Con.)

Province (Il) County Name	Description
Ordu:	
Korgan County: Geci	Geology: Deposit in hill country at elevation of 700 m. Mn occurs at contact of andesite and red marls. Deposit consists of thin beds striking E.-W., dipping flatly. Mineral is pyrolusite. About 8-10 percent of run-of-mine ore becomes marketable, with an average grade of Mn 40-46 percent, SiO_2 8-10 percent, Fe 4-5 percent. Transportation: Mine is near village of Geci, 5 km. by train from Korgan (Lat. 40° 50' N.; long. 37° 20' E.). Korgan is 35 km. by a very bad road from Fatsa.
Ordu County: Akoluk	Ownership: S. Akdan. Geology: Mineralization (1/2 to 2 m.) is at contact of andesite and andesite tuffs. Ore mainly pyrolusite. About 10 percent of run-of-mine ore becomes marketable, having a composition of Mn, 47 percent; SiO_2, 10 percent; Fe, 4.5 percent; P, 0.029 percent. Transportation: Akoluk mine is near Akoluk village, 8 km. by trail from Ordu-Koyulhisar highway. Junction is 37 km. from Ordu.
Fatsa County	Deposit near Tahtabaşi.
Zonguldak:	Number of Mn occurrences (sedimentary origin) occur in area 40 km. long (E.-W.) and 8 km. wide (N.-S.) E. of Ereğli toward Devrek, about 20 to 25 km. due S. of Zonguldak. Most deposits are a short distance N. of Ereğli-Devrek road. All occur in Senonian marls, volcanics and tuffs. Pyrolusite is dominant ore mineral in most deposits. Majority of deposits are lenticular or pocketlike and occur in red marls. Examples are Kabagoz (3 km. from village of Aydin), Gözören, Oda Başi, Turba Tepe, and others. Ore mineral principally pyrolusite. Manganese concretions in marls is type of deposit in Gökçe pinar. In conglomerate-type ore (Orta köy, Aşa sal) pyrolusite and psilomelane form groundmass between andesite fragments but sometimes blocks of pure pyrolusite are also found. Manganese in a mixed country rock of marl and tuff is represented by Kiz lamba deposit near Ramazanli village and Kara boya near Güllük village. Kiz lamba has a bedded form, with reserves estimated at 200,000 metric tons. Run-of-mine carries about 45 percent Mn and 8 percent SiO_2. In Kara Boya in 1951 and 1952, a number of small manganese deposits near surface and lying between andesite tuff and marl were worked as opencast.
Kabagoz	
Gözören	
Oda Basi	
Turba Tepi	
Gökçe pinar	
Orta Köy	
Aşa Sal	
Kiz lamba	
Kara boya	
Yakatarla	
Yelce	
Serdaroğlu	
Mantar	
Ulus County: Cubuklar	This mine, belonging to Ismail Ergener, produced 4,215 tons of ore in 1954.

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TABLE 24. - Manganese deposits in Turkey (Con.)

Province (Il) County Name	Description
	Aegean coast
Balikesir: Edremit Tamaslik-Havran (9 km. E. of Edremit and 19 km. from Akçay seaport)	Owner: Sakir Yorulmaz. Reserves: Indicated: 8,000-10,000 metric tons (1950). Geology: Irregular lenses of Mn ore (braunite) occur along tectonic lines in limestone, in andesite or at contact of the two. Larger lenses may have several hundred to a couple of thousand tons of ore and are found in crushed zones in limestone. These lenses are often separated by many hundred meters of barren limestone. Grade of ore is usually poor: Mn 28-45 percent, SiO_2 7-15 percent, Fe 4 percent.
Dursunbey County: Çalticak Hasimlar	Owner: Sakir Yorulmaz. Reserves: Inferred: 2 deposits near Çalticak with inferred reserves of 30,000 tons; for deposit near Hasimlar, no grade or tonnage available. Geology: Mn ore (braunite) occurs in reddish metamorphosed schists as irregular pockets and lenses up to 100 tons. Ore composition: Mn 35-46 percent, SiO_2 20-25 percent, Fe 3 percent. In Çalticak there are jasper beds adjacent to ore body. Transportation: Hasimlar, and Çalticak are, respectively 9 and 3 km. from the Gökcedağ R. R. station. Railroad distance, Gökcedağ to Bandirma port, is 240 km.

Molybdenum

Official statistics record the production of 1,358 tons of molybdenum ore in 1953 but none thereafter. In 1952 a molybdenum deposit was discovered in altered granite porphyry near the village of Gelemiç in Bursa Il. Reserves are reported to be 500,000 tons of 0.4 percent molybdenum. The Türk Molibden Şirketi was formed in 1955 to exploit this deposit. No information is available as to when production might begin.

Tungsten

Recorded production of 250 tons of scheelite in 1954 probably was obtained from exploration of a deposit 15 km. in a direct line southeast of Bursa, at an altitude of 1,950 to 2,130 meters on the northern slope of Ula Dağ. The access road from Bursa to the deposit is 44 km., part of which is asphalt paved. Bursa is connected to the port of Mudanya by a good 32-km. road.

The mountain peak consists of a large anticline of gneiss, amphibolite, and granite intruded in the core by a granite. Mineralization is found in a 60-meter-wide skarn (lime-bearing silicates) formed at the summit of the anticline at the contact of the granite and marble and at the base of the marble. The skarn ore, varying greatly in metal content, occurs in lenses consisting mainly of garnet and diopside.

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In the mines of Özdemir Antimuan the vein is more regular, wider, and of higher grade. The vein strikes N.-S., dips 35° to the west, and is 150 meters long. Geological evidence does not suggest that the ore body will have a horizontal extension beyond the present known length, so that the mine reserve is limited. Run-of-mine ore carries about 13 percent Sb. The company has a plant for smelting the hand-cobbed 65 percent concentrate produced.

Bauxite

No bauxite is produced or consumed in Turkey. Turkish deposits are limestone bauxite. Occurrences have been reported by the MTA in the following localities: Akseki in West Taurus Mountains, Antalya Il; Cebbardağ near Islahiye, Gaziantep Il; and Kokaksu, Devrek County, Zonguldak Il. Of these, the Akseki deposits are the best. They occur in the mountainous terrain of Seyran Dağ, 4 to 30 km. from Akseki village, which is connected to the Mediterranean coast by a 90-km. road. The terrain would make mining and transportation difficult. The bauxite occurs in Cretaceous limestone, which is part of a comprehensive limestone series extending from Lias to Eocene. The mineral is pisolitic and gray, yellow, brownish-red, or cherry-red; it may be a monohydrate. The measured reserve is supposed to be about 5 million metric tons, and the indicated reserve is 2 or 3 times as large. Analysis of various samples has shown an alumina content of 51 to 68 percent, with SiO_2 about 5 percent, although some samples have a silica content of 11 to 23 percent. The iron content is consistently high - 15 to 20 percent.

The occurrences of Islahiye-Payas are within the Cretaceous limestone. The reserve is given as 5 million tons, but much of the bauxite is high in iron and silica, and the low-silica ore is difficult to mine selectively. Analyses of over 100 samples showed an Al_2O_3 content of 45 to 50 percent.

The Zonguldak deposits are by the roadside at Kokaksu, 3 km. inland from the port of Zonguldak; they lie on limestone outcrops. Reserves are estimated at 140,000 metric tons of hard, good-quality material and 1,000,000 tons of soft, low-quality bauxite. Analyses of samples from the two types of ore are as follows, in percent:

	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition
Hard bauxite.....	55	20	5.0	3.00	13.0
Soft bauxite.....	40	10	30	2.50	15.0

Copper

Production and Trade

Copper production on an industrial scale was begun in 1936. From 1936 until 1950 the output came principally from the Ergani deposit and smelter and averaged 9,300 tons of metal annually for 1938-50, with a maximum of 11,700 tons in 1950. After 1950 production increased considerably, because the Murgul smelter came into operation. The present rated annual capacity is 25,000 tons of blister copper. Both installations are Government owned.

In 1956 Ergani contributed 17,390 tons and Murgul 7,045 tons to the total of 24,245 tons of blister-copper production (see table 1). The respective 1955 production figures were 17,016 and 6,724 tons of blister copper.

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Ergani's ore production in 1956 was 230,950 tons. Of this, 114,000 tons was treated in the flotation plant, the remainder being direct-furnace ore averaging perhaps,10 percent copper. Concentrate produced in the mill was 28,555 tons. The Murgul ore is poorer in grade. Of 354,306 tons produced in 1956, 335,534 was milled to give 31,588 tons of concentrate, with a copper content of perhaps 24 percent.

Turkey has no electrolytic refinery, but a plant at Kağithane (Istanbul) capable of refining 4,000 tons of blister copper per year is scheduled to begin production in 1958. The plant will be operated by Rabak Elektrolit ve Mamulleri A.Ş. founded by a number of banks and private individuals. Byproducts will be 2,000 kg. of silver and 40 kg. of gold.

The entire domestic production is available for export. Shipments of copper metal from Turkey, by countries of destination, are shown in table 25. The total value of copper exports in 1953 (including blister and ore) was TL 41,965,422 ($14,987,650), or 3.8 percent of the total 1953 exports; corresponding 1956 figures are TL 47,600,928 ($17,000,331) and 5.6 percent.

TABLE 25. - Exports of copper metal from Turkey, by countries of destination, 1937-56
(Metric tons)

Source: Annual Foreign Trade Statistics, Turkey

	Czecho-slovakia	France	Germany	Hungary	Rumania	Switzer-land	United Kingdom	United States	Other	Total
1937....	-	-	-	100	-	-	-	400	11	511
1938....	-	-	-	15	-	-	-	1,965	-	1,980
1939....	-	-	-	-	-	-	-	5,572	760	6,332
1940....	-	-	-	10	-	-	72	4,713	-	4,795
1941....	-	-	1	698	50	241	-	-	-	990
1942....	-	-	2,711	477	126	292	-	945	-	4,551
1943....	179	-	5,158	670	922	2	500	1,630	571	9,632
1944....	-	-	2,144	593	250	222	506	2,525	27	6,267
1945....	-	-	-	-	-	-	-	-	338	338
1946....	-	5,000	-	-	127	-	-	17,250	1,191	23,568
1947....	450	1,388	-	100	24	-	-	1,575	1,895	5,432
1948....	-	-	-	-	300	-	-	-	944	1,244
1949....	500	-	-	1,400	-	-	-	4,200	1,130	7,230
1950....	865	300	-	750	-	400	-	3,000	1,001	6,316
1951....	1,092	1,100	2,703	823	-	1,000	-	-	1,097	7,815
1952....	500	4,700	6,021	-	-	-	-	3,946	1,500	16,667
1953....	-	-	5,199	-	-	-	4,300	8,138	60	17,697
1954....	-	-	9,103	-	-	-	-	1,203	1,400	11,706
1955....	-	-	6,600	-	-	-	3,324	1,130	1,000	12,054
1956....	-	-	7,700	-	-	-	4,396	5,100	2,000	19,196

Information is not available on the tonnage of copper consumed annually in Turkey, but imports averaged 1,361 tons per year during 1946-55 (table 3). The imports consist of semifinished products, such as sheets, wires, and tubes, which are not produced locally. Imports are obtained mainly from the United Kingdom, Germany, United States, and Belgium.

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Mines

Ergani Copper Mine

The Ergani mine (1,220-meter elevation), mill, and smelter are in the Elazığ Il, on the west bank of the Tigris River and within a couple of miles from the Maden railway station. The area is one of steep topography; buildings, mill, and smelter are on valley sides (figs. 24-26).

Reserves of high-grade direct smelting ore may be less than 1 million tons. However, the disseminated ore below the Ergani massive pyrite ore body and the low-grade ore in the newly developed Weiss mine, adjacent to Ergani, add another 3 to 4 million tons to the reserves.

The average number of daily workers in 1953 was 1,550, distributed as follows: Mine, 270; mill, 115; smelter, 410; miscellaneous, 755. In addition, supervisory and office personnel employees number 120.

The geology of the Ergani mine is rather complicated. Basic rocks are widespread and consist of serpentine (peridotite), gabbro, and diabase. Although the exact relationship of these formations is not clear, the serpentine is supposed to be the oldest member and is intruded by the gabbro. The diabase is younger than the gabbro and often is altered to uralite, chlorite, and epidote. Alteration is at a maximum in the vicinity of the ore body. It is difficult to differentiate between the gabbro and the diabase. A widespread formation overlying the diabase is the upper Cretaceous-Eocene flysch. The red schist in the mining area belongs to this series and is supposed to have constituted the impervious layers beyond which the mineralizing solution could not penetrate. These solutions were brought along a fault zone striking east-west to northwest-southeast.

The ore body is encased in serpentine to the south and is in contact with schist or diabase to the north. It is oval in horizontal section, with the long axis about 360 meters in an east-west direction and the short axis about 170 meters. The serpentine country rock is free of mineralization, but the diabase is mineralized and has undergone extensive chloritization.

The upper part of the deposit is massive pyrite and contains the greater part of the copper ore; under the massive ore is disseminated ore. The massive ore, averaging 10 percent copper, is composed of pyrite, chalcopyrite, covellite, and a little chalcocite. A typical analysis shows Cu, 10 percent; Fe, 40 percent; and S, 48 percent. The disseminated ore carries 4 to 5 percent Cu.

Northwest of the main ore body is another one called Arpa Maidan, 50 to 100 meters in horizontal dimension and 30 meters thick. Arpa Maidan is believed to be a part of the main ore body but is separated from it by a mass of diabase.

A considerable extent of ancient workings is found in Ergani. Estimates indicate that as much as one-third of the ore body was removed before present operations began; and in the quarry quantities of filling have been left by the ancient miners who followed the shale contact, presumably because it was easier to excavate.

Mining is done by the opencut method. Eight benches (5 by 8 meters) have been arranged as follows: 1,203- and 1,215-meter levels, good ore; 1,224- and 1,230-meter levels, poorer ore; 1,240-meter level; 1,260-meter level; 1,277-meter level, 1,288-meter level. The pit bottom is at 1,203 meters, and ore extends upward from this to

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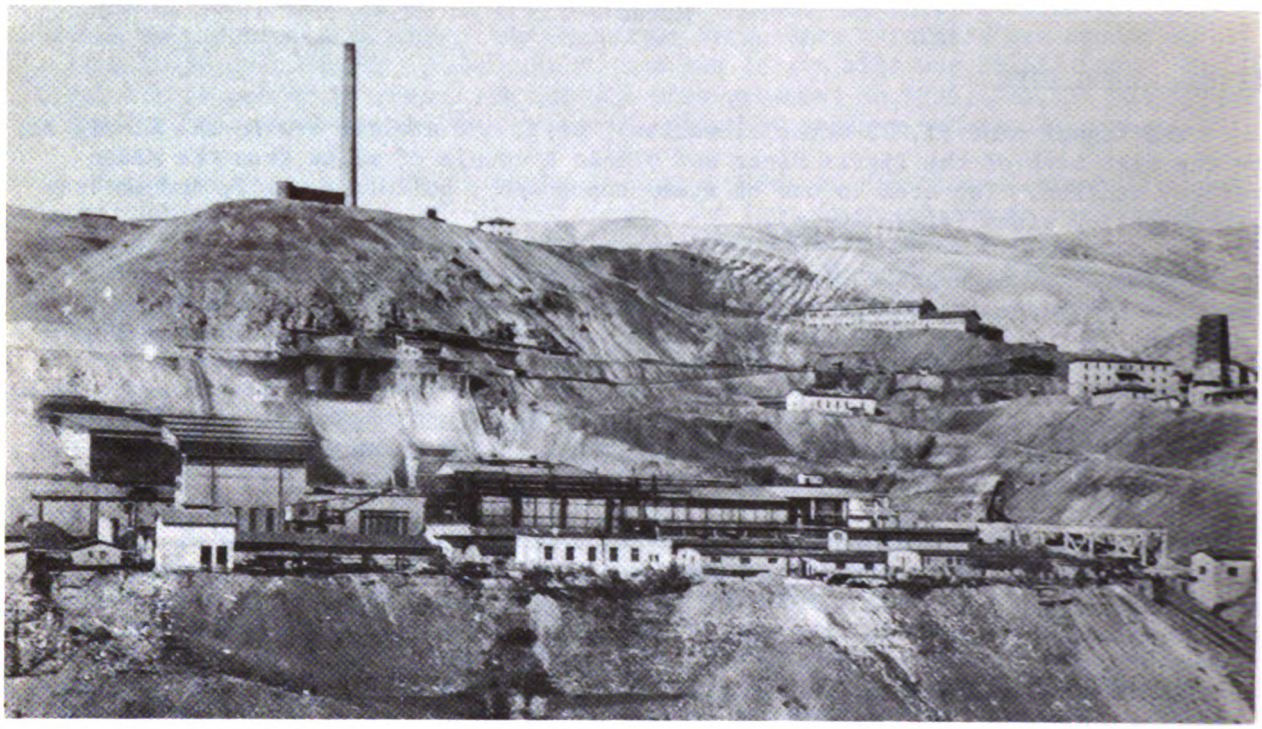

FIGURE 24. - Ergani Smelter, Turkey.

FIGURE 25. - Ergani Mine, Looking North.

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FIGURE 26. - Ergani Mine, Workers' Dwellings.

the 1,230-meter level; the other benches are for stripping. From the 1,203- down to the 1,143-meter level, disseminated ore is found. To develop the disseminated ore, a small shaft is sunk from the 1,203-meter level for a vertical distance of 50 meters. Twenty meters below the shaft collar (1,183 meters) a heading has been driven, mainly to explore the ore body. An upward incline will connect the 1,183-meter level to the pit bottom for moving ore when underground mining of the disseminated ore is begun.

The opencut has reached the horizontal limits of the ore body in some places. Stripping is by shovels. Compressed-air drilling is used in mining, but usually little blasting is required for breaking ore. Ore loading into mine cars and tramming are done by hand. At each level is a 60-cm.-gage track. Ore is trammed in small cars (1.5 cu. m.) to gloryholes that go down to the 1,203-meter level. From this level ore cars are hauled by diesel locomotives through a 350-meter haulage tunnel to the mill and smelter.

Ergani Mill. - The mill, built by the Western Knapp Co. of San Francisco, is about 1/2 mile east of the mine at an altitude of about 1,220 meters. Ore from the opencast is screened near the smelter. The plus-20-mm. portion goes directly to the smelter; the minus-20-mm. portion to a mill (300 tons per day, design capacity), where copper concentrate, pyrite concentrate, and tailing are produced by flotation. The mill flowsheet is shown in figure 27. The mill treated 114,000 tons of ore in 1956 or about 325 tons per shift. Mill feed consists of fresh pyritic ore (Cu, 6.3 percent; Fe, 42.3 percent; S, 48.4 percent; $CaO + SiO_2$, remainder) and dump ore (Cu, 4.4 percent; Fe, 42.9 percent; S, 48.9 percent; $CaO + SiO_2 + H_2O$, remainder) from the stockpile of fines accumulated before the mill was constructed. About 55 tons of concentrate (25 percent Cu) is produced daily. The pyrite is sold or stockpiled

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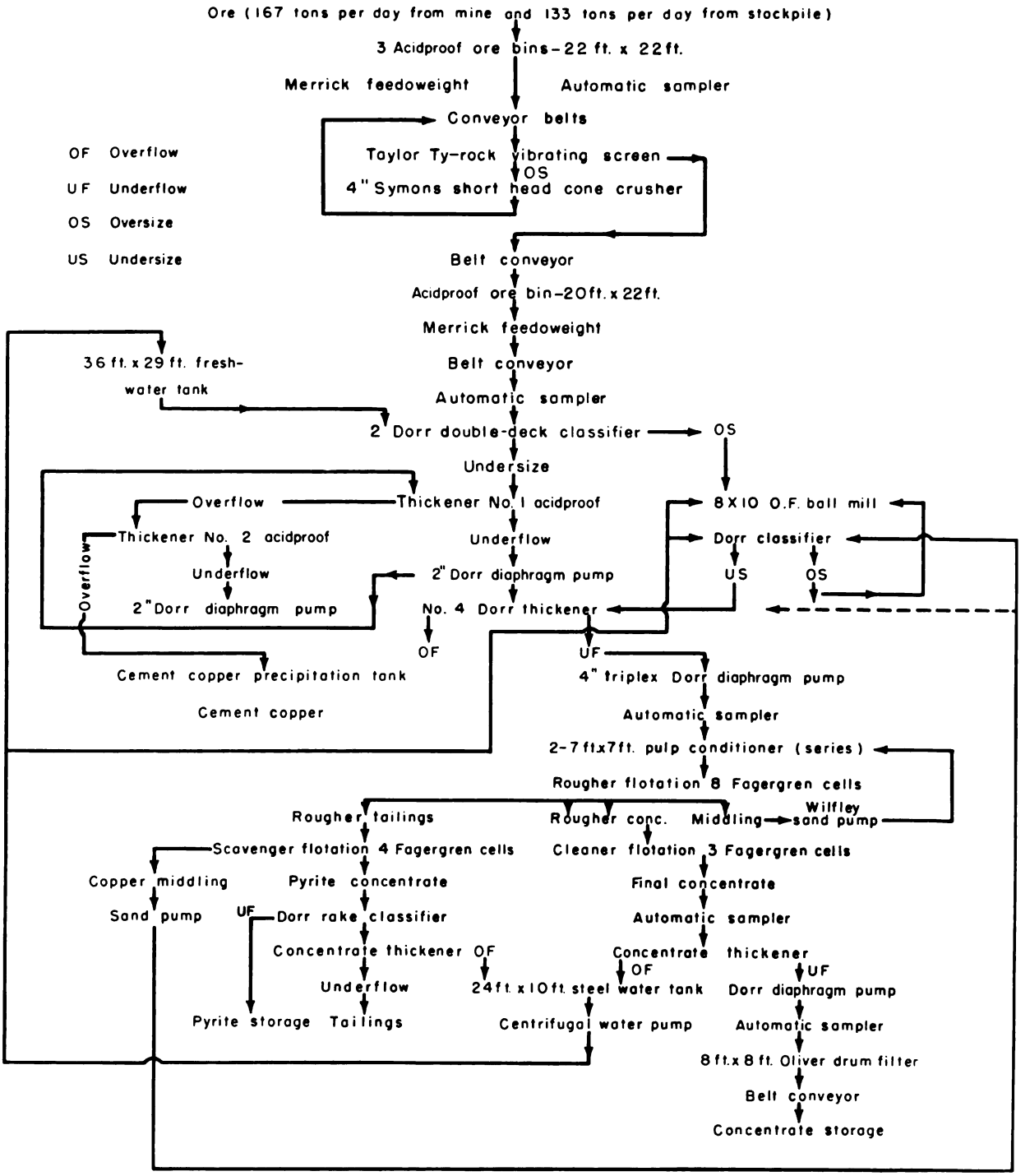

FIGURE 27. - Simplified Flowsheet, Ergani Copper Mill, Turkey.

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for future sale. Annually, 300 to 700 tons of cement copper is also recovered by treating mine waters with scrap iron. Recovery of cement copper in 1956 was 328 tons. Mill recovery is nearly 90 percent. As the massive ore is depleted and disseminated ore mined, expansion of the present mill capacity to treat the larger tonnage of lower grade material becomes necessary. Furthermore, the blast furnace (see below) will have to be replaced by a reverberatory furnace because the bulk of the copper will be in the form of concentrate.

Ergani Smelter. - The smelter, (completed in 1939) consists of sintering pots, water-jacketed shaft furnaces for producing matte, and converters for producing blister copper. The average daily production is 55 tons of sinter, 126 tons of matte carrying 36 percent Cu, 43 tons of blister copper, and 97 tons of converter slag.

Copper concentrate carrying 11.5 percent moisture is sintered in 9 Huntington Hebelein pots, each with a capacity of 3-1/2 cu. m. The charge for each pot consists of 3,500 kg. concentrate, 1,000 kg. silica, 850 kg. coke, and 1,000 kg. fine agglomerate. Flue dust is added when available and the amount deducted from the mine agglomerate. The charge is sintered 2-1/2 to 3 hours. However, each pot sinters only one batch per shift, because the pot must be cooled before it can be recharged. The pots are hand charged and require the services of 60 men.

Coarse sinter and lump ore are smelted in 2 water-jacketed shaft furnaces, each 5.6 by 1.2 meters at the tuyère level, giving a smelting capacity of 500 tons a day. At any one time only one furnace operates, the other being a spare. The average daily charge to the furnace consists of: Lump pyritic ore, 300 tons; sinter, 55 tons; cold converter slag, 55 to 60 tons; siliceous flux, 74 tons; limestone, 20 tons; hand-briquetted copper concentrate, 11 tons; coke, 26 tons. The mixture is hand-charged every 16 minutes from a platform at the top of the furnace. Slag runs continuously into special cars, but the matte is drawn every 4-3/4 hours, in a forehearth in which 42 tons of converter slag is poured daily. Coke consumption is 5 percent of the charge, the high sulfur content of the ore supplying the greater part of the heat. Combustion gases go to the chimney via dust chambers, where flue dust is collected at the rate of 15 tons a day.

The matte then goes to one of four 10-ton Pierce-Smith converters, each 300 cm. in diameter by 539 cm. in length. Only 3 converters are operated at a time, as only 3 blowers are available. The charge to each converter comprises 31 tons of matte and 6 tons of silica. The following quantities are smelted daily in the converters: Copper matte, 120 tons; siliceous flux, 22 tons; and cement copper (70 percent Cu), 1 to 1-1/2 tons. The blister copper is cast in a long bay of stationary molds.

The blast furnaces use 400 cu. m. of cold blast per minute and each converter 100 cu. m. per minute. Air is supplied to the blast furnaces by 2 blowers (525 cu. m. per minute at 36 mm. mercury); and to the converters by 3 blowers (100 cu. m. per minute at 0.5 atmosphere).

Ergani Powerplant. - The mine has its own powerplant of 2 steam turbogenerators of 3,000 kw. each and a 200-hp. diesel unit. Zonguldak coal is used for raising steam. The plant also supplies power to the Güleman chromite mine.

Auxiliary Installations. - An inclined railway raises standard railway cars from the Maden railway station on the Tigris (1,050-meter elevation) to the smelter, at 1,140 meters; and a smaller incline near the smelter transfers fuel and flux to the bin level. The mill also has an incline for transferring stockpiled ore to the mill bins. Pumps draw 1,088,000 metric tons of water per year from the Tigris and distribute it to the mine, mill, smelter, powerhouse, and shops.

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Byproducts. - Recovery of cobalt from Ergani ore or the converter slag has been the object of much experimentation. The run-of-mine ore carries 0.35 percent Co. Ore-dressing methods have failed to concentrate the cobalt, because it is associated with pyrite and chalcopyrite, replacing part of the iron in these minerals. A buildup of cobalt occurs in the converter slag, because the slags are circulated back to the blast furnace. Other factors indicate that, to attempt recovery of cobalt from any of the smelter products with the present practice is not feasible. Leaching of the ore is perhaps the most promising method, although this may not be economical with an ore carrying so little cobalt.

No attempt has been made to recover the sulfur, either as sulfur dioxide from flue gases or as elemental sulfur. An estimate indicates that sulfur is burned at the rate of 140 metric tons a day, without considering the sulfur burned in the sintering machines.

Murgul

The copper mine is near Murgul village in the Çoruh Il, southeast of the port of Hopa and at an elevation of 1,160 meters (3,800 feet). Murgul is reached by a 56-km. dirt road from Hopa, a Black Sea port. Mining was carried on at Murgul before 1916. The Eti Bank took over the property in 1938 and began to develop it. However, progress was slow because of World War II. Production was begun in 1951; the annual production of blister copper, 1951-56, inclusive, has been 3,346, 8,344, 8,802, 8,500 6,724, and 7,045 metric tons, respectively. The present labor force is about 1,800.

The decrease of production to 7,045 tons in 1956 instead of the rated capacity of 12,000 tons results from fall of grade of ore from 3 to 2.3 percent copper and from the extreme hardness of the rock, which has reduced the daily capacity of the concentrator from its rated 1,500 to 1,000 tons, per day. The Eti Bank is engaged in increasing the production capacity of the mine by purchasing additional shovels and other equipment. Simultaneously, mill and aerial tramway capacities will be increased to 2,000 tons per day.

According to P. de Wijkerslooth (21), the Murgul deposits belong to the East Pontion metallogenic zone - a broad zone that parallels the Black Sea between Samsun and Hopa and extends southward to Gümüşhane. This area is characterized by abundant volcanic rocks. Acidic volcanics, such as spilite, andesite, dacite, and rhyolite, were followed by basic olivine basalt and leucite tephrite. The last phase of plutonic activity was intrusion of granitic and granodioritic intrusions in the andesite-dacite masses that brought the mineral-bearing solutions along existing faults. The mineral deposits of the zone are of "subvolcanic" type, relatively near the surface, and characterized by lateral discontinuity.

The Murgul deposit consists of several irregular, subhorizontal lenses in a thick complex of andesite-dacite and formed by the metasomatic alteration of the dacite; the largest lense is Çankara; others are Sosveni and Satep (20). These ore bodies have a sharp contact at the hanging wall, but the foot-wall contact is not defined and is determined by economics of mining. The Çankara ore body strikes 300 meters with a workable width of more than 50 meters and in places 70-80 meters. The deposit increases in size with depth; at the 1,150-meter level it measures 500 meters in a northwest-southeast direction, with a maximum width of 290 meters in the west and 200 meters in the east. The hanging wall is propylitized dacite and the foot-wall is silicified and kaolinized andesite and tuff. Sosveni measures 100 by 50 meters in the opencast and Satep 100 by 60 meters.

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Originally reserves were estimated at 7,000,000 tons of 3-percent ore; recent exploration has increased the estimate to about 16,000,000 tons but at a lower average grade of about 2 percent copper, with a total copper content of 333,000 tons. Ore minerals are pyrite and chalcopyrite as a stockwork in dacite. The principal gangue is quartz. Mine-run ore carries 2.3 percent Cu, 8-9 percent Fe, 8-9 percent S, about 80 percent SiO_2, 1-4 percent Al_2O_3 and 1-3 percent CaO + MgO.

Ore is won at a daily rate of 1,500 tons in an open pit, with benches at 10-meter intervals; waste is hauled in trains of 1.5-cu.m. side-dump cars. Ore is trammed in small mine cars to gloryholes and chutes and drawn on at the 1,150-meter haulage level. Four 2-yard shovels are used for stripping overburden. Compressed air for mining is delivered by 2 compressors with a total capacity of 100 cu. m. of free air per minute. The ore is crushed to 5-inch size and conveyed by a 2.6-km. aerial tramway to the concentrator 580 meters below the mine elevation.

The flotation mill consists of 3 identical units designed to treat a total of about 1,500 tons of ore daily, producing 150 tons of concentrate with 20-25 percent Cu, 40 percent Fe, 45 percent S, and 3 percent SiO_2. The smelter installation consists of one 5.5- by 22.8-meter (18- by 75-foot) reverberatory furnace, two 3- by 6-meter (10- by 20-foot) Pierce-Smith converters, one 40-ton-capacity fire-refining furnace, coal-pulverizing plant, waste-heat boiler, direct-fired boiler, and casting machine. The blister copper contains 0.39 ounce of gold and 28.29 ounces of silver per ton. Coke for smelting the concentrates is shipped from Karabük.

A 200-ton-per-day sulfuric acid plant is under construction and will use the SO_2 from the smelter. The sulfuric acid will go to a 100,000-ton-per-year superphosphate plant at Iskenderun and a duplicate plant under construction in Trabzon. Power is obtained from a 4,400-kw. hydroelectric plant. Waste-heat boilers supply thermal power to supplement the hydroelectric power.

Kuvarşan

The Kuvarşan mine, also in the East Pontian metallogenic zone, is a few miles from Batum. It was operated several years and produced about 1,000 tons of copper annually. Reserves in this mine have been exhausted, and mining stopped in 1944. Production data for 1937-44, in metric tons, are as follows: 1937, 653; 1938, 2,240; 1939, 2,500; 1940, 1,924; 1941, 1,417; 1942, 857; 1943, 495; 1944, 904.

Miscellaneous Copper Deposits

In 1956 Küre Piritleri Türk Anonim Şirketi, a subsidiary of Eti Bank, started exploiting a cupriferous pyrite deposit at Küre, Kastamonu Il, some 31 kilometers south of the Black Sea port of Inebolu. Reserves are estimated at 1,600,000 tons with 1.9 percent copper and 48 percent sulfur. South of Küre existence of a large tonnage of slag assaying 1.5 percent copper is reported at Kastamonu, but recovery of the copper will present metallurgical difficulties.

According to Ryan's Guide, there are 71 known copper occurrences in 26 Provinces of Turkey. Many of these are of unknown extent and value and probably have no economic significance. Halezur cupriferous pyrite, 25 air-kilometers south southwest of Elazığ, is considered a favorable prospect.

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Lead and Zinc

Production

Production of lead ore in Turkey has been intermittent and irregular. The largest producer was the Balya-Maden mine group, 60 km. southeast of Biga in Balikesir Il. These mines were operated by the Société Anonyme Turque des Mines de Balya Karaydin. The lead-zinc ore was concentrated in a mill. To obtain an idea of the scale of production, the following figures (in metric tons) pertaining to 1936 operations are quoted from the 1937 annual report of the company: Ore mined, 61,453; ore treated, 59,089 new ore, 67,985 old rejects; galena concentrate, 7,187; blende concentrate, 17,485. Some of the lead concentrate was smelted locally, and the remainder and all the zinc concentrate were exported. Company activities stopped in 1940, perhaps due to cancellation or termination of the concession. The mill is believed to have been dismantled and transferred to the Keban mine (see below). The condition of the lead smelter is not known.

Since termination of company activities lead-ore production has been on a small, intermittent scale, varying from a few hundred to several thousand tons from mines other than the Balya-Maden. The large increase in production in 1953 and 1954 came from the Keban mine, which went into operation in 1953. This mine produced 911 tons of lead concentrate (59 percent Pb) in 1953 and 1,572 tons in 1954.

Turkey's present consumption of lead and zinc metals is not known. Imports of these metals during 1937-55 are shown in table 3.

Principal Mines and Deposits

Known deposits are all old workings. In the Pontides from west to east are the mines of Karasu and Gümüşhane and in the Intermediate Zone, proceeding in the same direction, are Balya, Zara, Keban, Bolkardağ, and Bereketi. Of these, perhaps Balya, Bolkardağ, and Keban are the most important. According to the annual report already cited, 130,000 tons of ore was developed during 1936 at the 280-meter level of the Orta mine. It is therefore likely that these mines still have unmined ore. The mine was explored in 1956 by a subsidiary of an American Company in Turkey.

Bolkardağ

The Bolkardağ mine is at an altitude of 1,500 meters (5,000 feet) in the Bolkar Mountains, north of Taurus, 15 km. southwest of Çiftehan railroad station and 70 km. north of the Mediterranean port of Mersin. Çiftehan is 125 km. by rail from Mersin and 242 km. from Iskenderun. A dirt road connects the mine to the Çiftehan railroad station. Exploration and development work have been carried out between the 1,800 and 2,500-meter altitudes.

The principal massif of the Bolkardağ Mountain Range, which belongs to the Central Taurus, is a white, subcrystalline limestone several hundred meters thick, considered of Carboniferous age. The limestone appears to be covered by a series of chlorite and talc schists. Lying unconformably on this series are shales, conglomerates, and marls, which are probably Upper Cretaceous and are intruded by serpentine and diabase. The Upper Cretaceous formations appear to be unconformably covered by andesite and dacite flows, then by conglomerates and a few meters of calcareous marl containing nummulite (Eocene). In the vicinity of the mine are several dikes, 2 to 4 meters thick and 1 to 2 km. long, which cut the marmorized limestone. The dikes are probably microcrystalline.

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The mineralized zone is in fractured limestone, and the minerals occur as stratified masses. Country rock is invariably limestone. Galena and blende are the principal minerals and rarely pyrite. The vertical height of mineralization is 600 meters. As in the case of Keban, the zinc content increases with depth.

Veins occur of earthy oxidized minerals whose thickness does not exceed 1 meter. The vein minerals are jarositic. In these oxidized veins are found remains of galena, cerussite, anglesite, calamine, smithsonite, and hydrozincite and large quantities of limonite. The formation of jarositic minerals indicates the action of hypogene solutions. The existing reserves are in the form of placer or alluvial ore formed by surface water disintegrating and moving the oxidized minerals and depositing them in pockets and chambers. The reserves are 250,000 to 300,000 metric tons of ore, with the following composition:

Grams per ton		Percent							
Au	Ag	Pb	Cu	SiO_2	Fe and Mn	CaO	Zn	Al_2O_3	As
9	330	5.5	0.4	25.0	28.5	1.8	4.7	6.0	1.0

Development work has already been done in the mine to facilitate transportation of ore from old workings to a main haulage drift. Some buildings, but no mechanical equipment, remain at the mine.

The ore cannot be enriched at reasonable cost by ordinary ore-dressing methods; but direct smelting may be economically practicable, because of the precious-metal content. A proposal has also been made to combine the Bolkardağ ore with sinter from high-grade lead concentrate from Keban (see below) for blast-furnace smelting.

Veins of galena, blende, and pyrite in a limestone country rock occur in Bereketi Maden, about 45 km. NNE. of Bolkardağ and in the region of Faraş-Göksün, but their economic significance is not known.

Keban

The Keban mine (altitude, 760 meters) is on the left bank of the Euphrates River in the village of Keban, 55 km. west of Elâziğ. Elâziğ is connected by a short spur to the main Malatya-Diyarbakir Railroad, which goes also to the port of Iskenderun. The rail distance from Elâziğ to Iskenderun is 492 km. The deposit has been mined from olden times; much old slag from lead smelting is seen in the village of Keban. The MTA did some exploration in 1940, and in 1953 the Eti Bank began to operate the mine. The mining camp consists of several residential buildings, a powerplant, a small workshop, and a flotation mill.

The oldest rocks in the Keban area (according to Kovenko) are massive marbleized limestones, considered Paleozoic. This limestone is covered by a series of sericite, chlorite, and graphite schists, which are of largest extent in this area. Intercalated in these schists are thin beds of limestone. Lying unconformably over this series are conglomerates, marls, and grit of lower Eocene, which are in turn covered by nummulitic limestone. The general strike of the formations is north-south; faulting is in north-south and east-west directions.

At Keban a multitude of necks, dikes, and apophyses of syenitic porphyry intrude the schist but rarely the massive limestone. Other igneous rocks are post-Miocene lava flows. The syenites are supposed to be genetically connected with mineral deposition. The ore, which is pyritic and carries galena, blende, and sometimes marmatite, occurs at the contact of the massive limestone and sericite schists or at the

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contact of the limestone with syenite, but is not found in the syenite. Mineralization occurs along a thrust fault plane. Limits of the mineralized area are difficult to ascertain but may be 2,000 by 100 meters; signs of mineralization are seen, however, at the outcrop for many kilometers. The vertical height of mineralization may be 600 meters. The measured reserve is estimated at 87,000 tons of ore having a lead content of about 10-14 percent and a zinc content of about 12 percent. The lead content diminishes with depth.

The mine is entered by an adit, which also serves as the main haulageway, driven at 122° from the north for a distance of 600 meters. The level of the adit is about 750 meters at its entrance. In 1953 ore was won at a rate of 150 tons per day from areas left by old mining operations. The mine was operated 2 shifts per day, with a labor force of 200 and a staff of 10.

The ore is concentrated in an old mill of 150-ton-per-day capacity. The flowsheet is fairly simple and is shown diagrammatically in figure 28. A lead concentrate with 60 percent Pb is recovered; the zinc minerals go with the pyrite tailing, which is stockpiled for future recovery of zinc. The tailing carries 1 percent lead, 15 percent zinc, and 70 percent pyrite. Much of the galena can be recovered by jigs

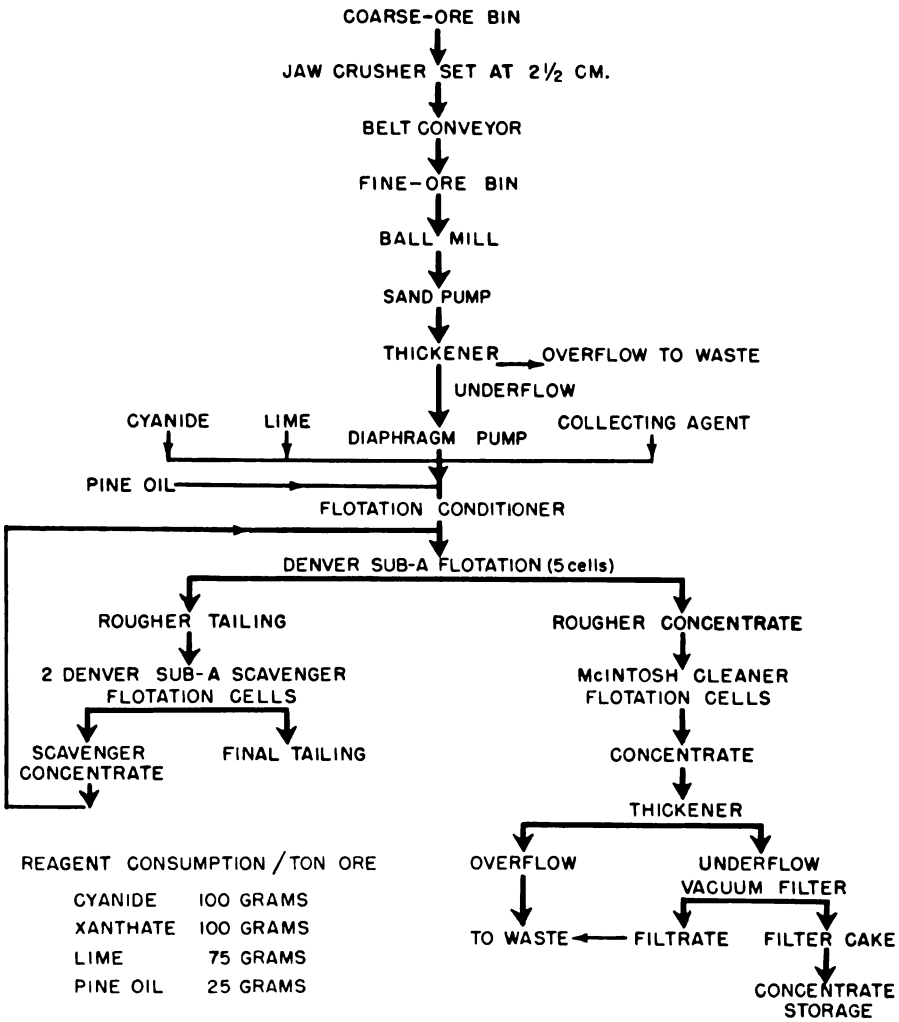

FIGURE 28. - Mill Flowsheet, Keban Lead-Zinc Mine, Turkey.

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before grinding to minus-100-mesh. Four large and two small shaking tables and a classifier are available in the mill. These are not used in the lead circuit but may be used for scheelite concentration if a nearby occurrence is worked.

The mine has a small diesel operated powerplant capable of generating 250 kv.-a. Of 2 compressors at the mine portal, 1 is a 10-cu.-m.-per-minute stationary unit, belt-driven from a 97-hp. electric motor, and 1 is a portable compressor, with caterpillar diesel.

Miscellaneous Deposits

Lead-zinc deposits also occur in several other localities, including the following:

1. A deposit near Davutlar, Balikesir Il, with a probable reserve of 125,000 metric tons of complex lead-zinc-copper-barite-gold-silver ore assaying 67 percent Pb, 1 percent Zn, trace Au, 15 oz. Ag per ton; barite and Cu percentage unknown (44).

2. Gümüşhane, near Dölek village, Gümüşhane Il, is an argentiferous lead deposit worked in olden times and investigated by MTA in the late 1930's. Remaining reserves are estimated at 230,000 tons of ore with 3.3 percent Pb, 3.2 percent Zn, 21.6 percent S and 89 grams Ag per ton.

3. A lead-zinc mineralized area at Ortakônuş village, Anamour County, Icel Il. The formation consists of metamorphosed schists at the base with limestone intercalations. Overlying the schists is dark, Mesozoic limestone, with conglomerate separating it from a white, sometimes dolomitized limestone, which occurs in layers 0.8 meter to 3 meters thick. Numerous faults in this area have preponderant directions northwest and northeast. The dolomitized limestone is the country rock, with minerals occurring as lenses or masses along the stratification. Oxidized minerals are smithsonite, cerussite, and limonite, assaying 22 percent Pb and 35 percent Zn.

4. The old Gümüşhacikôy mine near the village of Merzifon in Amasya Il. Here all visible ore has been worked out, and only investigation at depth will determine if any ore is left in place.

5. The old lead-zinc mines of Karasu occur 10 to 20 km. from the coast of the Black Sea in Kocaeli Il. A subsidiary of the French company working the Balya mines did some exploration in the Karasu Valley, but the work was not continued. Paleozoic shales and grits are covered by limestones. On this series lie crystalline dolomites (Upper Cretaceous) with depths of 100 to 250 meters. Overlying this are marls and platy limestone. Igneous rocks are absent, and the origin of the mineralization must be independent of igneous activity. The principal directions of the faults, which are numerous, are east-west or northeast-southwest. The mineralization is in the dolomitized limestones as small masses and disseminations. In the gossans are calamine, cerussite, oxides of iron, and copper. In the western part of the area (Akçukur, Acielma) blende is more predominant, whereas in the eastern part (Karasu, Çoban Yatak, Aktaş, Kabalak deresi) the veins are poorer in blende.

6. A great massif of granite, monzonite and quartz diorite, extending 120 km. east-west, underlies the Dènek region, Ankara Il. The massif is covered by thin sheets of limestone, often completely marmorized and metamorphosed. Here and there one sees altered tuffs. Oligocene marls and conglomerates cover the granitoid rocks transgressively. Of 3 fault systems, the Denek-Maden is the most important; it is 10 km. long, north-south in direction, and dips 50° to 70° W. The main deposits of Denek are in three blocks of sediments caught between the granite and green tuffs by

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the main fault. Mineralization is in the limestone at the contact with the tuff, which is the hanging wall. The veins are in the form of flattened columns, 0.20 meter to 1.50 meters thick, 8 to 10 meters long and 20 to 30 meters in inclined length. Valuable minerals are mainly pyrite and galena, with minor quantities of arsenopyrites; gangue minerals are carbonates and quartz. A stock of 2,100 tons of ore at the mine averages 31 percent Pb and 395 grams per ton of silver.

7. Akdağmaden, Yozgat Il, 80 km. by road from the station of Ildizli on the Sivas Samsun Railroad and 96 km. (airline) from Yozgat. About 40,000 tons of slag remains from previous smelting operations; the assay of a small quantity of this showed a lead content of 6.2 percent.

The intrusive at Akdağ (granite and quartz diorite) is in contact either with limestone (often metamorphosed to a coarse-grained marble) or with schists. The metamorphosed formations are surrounded by Lower Eocene, covered or penetrated by andesite and dacite lavas.

The best mineralization is in limestone or schist in the vicinity of the igneous intrusive as small veinlets or dissemination. Assays of a small quantity of ore have shown a lead content of 25 to 28 percent and zinc 32 to 34 percent. Galena, blende, and pyrite are the principal minerals.

In the village of Akçakişla, 25 km. southwest of Akdağ, small veins (25 to 35 cm.) occur in limestone. Mineralization extends 500 to 600 meters, with large intervals. Vein material contains 7.13 percent zinc and 2.53 percent lead.

8. In the Zara area in Sivas, east of Akdağ and 55 to 70 km. directly north of Divriği, are several old lead and antimony mines, lead predominating. A private company carried out exploratory work in the area surrounding the Kösedağ massif of granite or monzonite.

The Kösedağ Mountain is composed of granite and the Kizildağ of serpentine. The intervening area is underlain by crystalline schists. Nonmetamorphosed sediments are islets of marl and gritstone, covered with vast sediments of Oligocene marls and gypsum. Dacites and andesites cover an important area commencing north of the Oligocene terrain and continuing without interruption for 100 to 120 km. to the Black Sea.

Lead and antimony occurrences are at Kurtmaden, at Toludere (3 km. southwest of Saryeri) and at Deredem, 1 to 12 km. southwest of Saryeri. At Kurtmaden, andesites are cut by 5 veins, 20 to 70 cm. thick, 100 to 300 meters long, strike north-west, and dips 65° to 70° northeast. The gangue is almost exclusively quartz, and the valuable minerals are galena, blende, and pyrite. The veins are fissure fillings. At Toludere and Deredem stibnite occurs in granite. Veins are of the fissure type, with quartz as gangue. Analysis of a sample of material from Toludere showed 20.3 percent antimony and 194 grams of silver per ton and 0.4 gram of gold per ton.

Mercury

Past production of mercury before 1954 has come principally from the two mines Ahirli and Karareis, in Karaburun on the promontory facing Izmir. Karaburun mine belongs to Osman Tascioğlu and Karareis to Fehim Kiremitciler ve Ort. Annual production during 1940 to 1948 varied from a minimum of 30 to a maximum of 480 flasks. Installation and equipment are believed to be rudimentary. The deposits are considered to have some interest, but capital and technical assistance are needed to increase production. Production in 1954, 1955, and 1956 is from an old mercury mine, Sizma in Şille County, north of Konya.

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Turkey. Domestic consumption is small and is satisfied by imports of crude and manufactured asbestos. Imports of unmanufactured asbestos for 1937-56 are given in table 4.

Boron Minerals

Production of boron minerals in Turkey has fluctuated considerably. An annual average of 15,000 tons was mined until 1930, when production fell sharply, presumably because of competition from California sources. Owing to war stimulus, 15,000 and 23,000 tons was mined in 1939 and 1940, respectively. Production fell to 440 tons in 1944 but has increased again during the last decade, attaining a maximum of 42,186 tons in 1955 (table 1).

Turkish consumption is 2,000 to 3,000 tons a year; the remainder is exported. Export destinations, mainly European countries, are shown in table 26.

TABLE 26. - Exports of boron minerals from Turkey, by countries of destination, 1946-56[1/]
(Metric tons)

Source: 61.

Year	Austria	Czechoslovakia	France	Germany	Hungary	Poland	Spain	United Kingdom	Other	Total
1946	-	-	508	-	-	-	-	2,540	-	3,048
1947	200	10	1,892	1,727	-	-	250	2,286	-	6,365
1948	-	-	1,459	-	87	-	250	4,267	-	6,063
1949	50	-	3,672	97	400	1,305	500	2,487	-	8,511
1950	350	-	2,500	1,400	400	500	1,750	3,251	-	10,151
1951	650	-	3,750	1,399	1,536	-	1,800	3,417	-	12,552
1952	400	-	3,000	1,300	1,000	-	1,800	3,861	800	12,161
1953	350	200	1,930	500	1,225	-	1,410	3,048	600	9,263
1954	430	3,850	4,000	1,000	1,230	3,000	2,350	1,422	200	17,482
1955	1,150	7,055	2,851	500	2,558	7,200	4,850	2,438	2,800	31,402
1956	200	537	-	-	-	-	2,250	406	-	3,393

1/ Exports during 1940-45 were as follows: 1940, 5,380 tons (3,958 to United Kingdom and balance to France); 1941 and 1945, 1,930 and 2,032 tons, all to United Kingdom; 1942, 10 tons; 1943, 200 tons to Egypt; 1944, none.

Before 1954 boron minerals, mainly priceite ($5\ CaO.\ 6B_2O_3.\ 9H_2O$), were obtained from the Sultan Çayir mines in Susurluk County of Balikesir Il, 60 km. south of the port of Bandirma. In 1954 the reserve of this mine was virtually exhausted, and underground operations ceased. Since then production on a reduced scale has been obtained from the recovery of material in the extensive old dumps. In 1956, 6,800 tons was produced in this manner. Sultan Çayir mines are controlled by the British firm Borax Consolidated, Ltd., which has been operating them since 1887. The total output from Susurluk and its adjacent Aziziye mines is estimated at 1,000,000 tons.

The large increase in production in 1955 came about from the 1954 discovery of new deposits and development of mines in Bigadiç County in Balikesir Il, some 38 km. southeast of Balikesir on the road to Izmir. Present producers are Yakal Borasit, Ltd., Şirketi, working Günevi, Acep, and Tüğlü değirmen mines and Koşeçam prospect; Türk Boraks Madencilik A.Ş., the Turkish affiliate of Borax Consolidated, Ltd., working deposits near Beğendikler village; and Ali Sayakci and Rasih ve Ihsan, Ltd., whose properties are adjacent to those of Yakal Borasit. Faraş Çamkoy Ltd., Şirketi,

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a subsidiary of Yakal Borasit, operates Kireçlik mine. Colemanite and ulexite are the ore minerals in the above mines. In addition Bortaş Türk Madencilik Şirketi operates Kestelek mine in M. Kemalpaşa County of Bursa İl. Production from this mine may total 15,000 tons annually.

More recent exploration by MTA has shown large deposits (colemanite) near the village of Hisarcik, 12 km. by road south of Emet, Kütahya Il. The borate zone consists of marls, clays, tuffs, and borate lenses. A prospected 1,000-meter length shows an average thickness of 22 meters, with 15 meters of borate and 8 of waste. The total reserve is estimated at 7.7 million tons. Reportedly, Eti Bank is interested in exploiting these deposits. Compared to Bigadiç mines, ore transportation from Kütahya properties involves an additional 200 km. of rail transport from Emirler to Balikesir.

In Sultan Çayir the deposit is a uniform, almost flat, seam nearly 14 km. square in extent and up to 6 meters in thickness. It contains lumps or nodules of priceite bedded in gypsum. Only the large lumps are won and marketed after hand sorting. Where gypsum and the ore mineral are finely intergrown, the material has no value. The best grade ore averages 44 percent B_2O_3.

The newer deposits in Bigadiç County are in an area 9 km. east-west by 6 km. north-south, the center of which is 47 km. south of Sultan Çayir; they belong to the same Neogene Basin, in which Sultan Çayir is found. The mines are in the vicinity of the villages of Çamköy, Iskele köyü, Beğendikler, Osmanca, and Faraş köyü. The country rock is marly, bedded limestone, with concordant layers of montmorillonite, volcanic tuff, and several borate beds 10 meters high. These beds are 2 to 3 meters thick, with sterile areas, as well as swellings up to 6 meters. The gangue material is limestone or montmorillonite, but gypsum (which is abundant in Sultan Çayir) is absent here. The principal ore minerals are colemanite and ulexite. Colemanite-type ore averages 43 percent and ulexite 39 percent boron. The names and locations of principal deposits of Bigadiç County are given in table 27.

Mining is by underground adits and mining cost for the largest producer in Bigadiç area is estimated at TL 31 per ton. The difficult problem is support of mine working resulting in high timber consumption.

Ore is trucked about 50 km. from mines to Balikesir costing perhaps 20 TL per ton and then railed to Bandirma port at a further cost of TL 7.50.

Emery

Emery was discovered in Turkey in 1847. Annual production during the last decade has varied from a minimum of 1,421 tons to a maximum of 11,831, the average for 1945-56 being about 6,157 tons. The rate of production depends on export demand. Production is for the export market and can be increased considerably if demand develops. Great Britain is the principal buyer (60 percent during 1937-55) followed by Netherlands (29 percent) and the United States (16 percent). France, Germany, Austria and Sweden are other importers. The city of Milâs in Muğla Il is the center of the emery industry, and Güllük, 13 km. away, is the port of export. Using lighters, 250 tons daily can be loaded from Güllük. Price (1952) of the emery f.o.b. Güllük is $14 to $18 per ton for the "rain-wash" and about $18 per ton for the "river-wash" grade. Turkish emery carries about 62 percent alumina and 32 percent magnetic iron oxide. Four organized firms held mining concessions in 1952 in the Milâs area. These were Tarika Varisleri, Abbot Company, Ltd., Lotfollah E. Kitapci, and Michele Abauf; the latter was not active. The other 3 firms employed,

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respectively, 50, 100, and 50 men, whose principal activity, when not mining is farming. Tarika Varisleri sold its production mainly to the Abbot Co., Ltd., and to Kitapci, which have export contacts.

TABLE 27. - Principal deposits of boron minerals, Bigadiç County, Turkey

Il Name and location	Remarks
Balikesir:	Measured reserve: 100,000
Büyük Kireçlik N. of Çamköy (39°27'N.; 28°11'E.)	Borate horizon 2.5 to 3.0 m. thick, with clay partings. Montmorillonite is frequent as hanging- and foot-wall gouge. 1955 production: 3,420 tons.
Günevi 4 km. NE. of Iskele köyü (39°29'N.; 28°13'E.)	Measured reserve: 150,000 tons. Ore (3.3 m. thick) contains very little clay and is marketable without hand sorting. 1955 production: 5,272 tons.
Kurt pinari 1,500 m. SW. of Günevi	3-meter thickness of borates on strike with Günevi and Beğendikler.
Acep 1 km. SE. of Iskele köyü (39°29'N.; 28°10'E.)	Similar to Büyük Kireçlik. Hanging and foot walls are clay. 1955 production: 1,864 tons.
Beğendikler NW. of Beğendikler village (39°30'N.; 28°12'E.)	Reserve: 60,000 tons. Lenses of colemanite in tough clay; average thickness of borate bed 1.5-1.75 m. 1955 production: 4,500 tons.
Tuğlu değirmen 21 km. southwest of Osmanca village (39°28'N.; 28°10'E.)	2.0- to 2.5-m. bed of colemanite with high admixture of clay and shale partings. 1955 production: 100 tons.
Börekci deresi 1,800 meters WNW. of Çamköy	In E.-W. line with Tuğlu değirmen

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The long-term prospect for emery export, particularly to the United States, is rather unfavorable, because carborundum has made inroads in the abrasive field, and the United States is producing emery domestically. Emery exports, by countries of destination, are shown in table 28. Imports of emery and other abrasives for 1950-56 are shown in table 4 and for 1937-49 were as follows:

Year	Emery and carborundum	Others	Year	Emery and carborundum	Others
1937	20	226	1944	-	179
1938	13	182	1945	1	217
1939	24	239	1946	10	218
1940	26	178	1947	9	401
1941	8	35	1948	9	611
1942	4	96	1949	5	457
1943	5	275			

TABLE 28. - Emery exports from Turkey, by countries of destination, 1937-56
(Metric tons)

Source: Annual Foreign Trade Statistics, Turkey.

Year	France	Germany	Netherlands	United Kingdom	United States	Other	Total
1937	-	939	1,202	6,250	3,138	480	12,009
1938	-	1,450	715	4,250	1,230	625	8,370
1939	500	810	720	5,950	1,500	600	9,550
1940	-	-	-	5,780	3,620	491	9,893
1941	-	-	-	906	-	4	911
1942	-	-	-	10,496	-	29	10,525
1943	-	-	-	2,754	-	24	2,778
1944	-	-	-	-	-	56	56
1945	-	-	-	4,401	-	678	5,079
1946	-	-	1,644	5,702	2,408	588	10,342
1947	600	-	2,300	5,440	2,717	340	11,399
1948	1,133	-	500	6,198	1,854	44	9,729
1949	630	-	1,000	5,619	508	824	8,581
1950	600	300	1,605	3,657	2,074	100	8,337
1951	300	-	1,620	5,617	2,540	812	10,889
1952	-	-	900	3,566	-	1,771	6,237
1953	500	-	925	1,773	-	54	3,253
1954	-	-	1,498	6,457	508	130	8,593
1955	580	-	2,790	3,353	1,524	1,131	9,379
1956	384	-	2,700	4,267	1,016	331	8,698

Rather extensive deposits of emery are reported in the vicinity of Izmir, Muğla, and Aydin, in southwest Turkey. In the karst-type high plain of Askivri northwest of Milâs, hollows in crystalline limestone are filled with tough red clay. The emery occurs in the red matrix, fairly near the surface, and in the bed of Sariçay river. Alluvial emery is also won in the river bed of Ysufca. Emery from the river bed, known as "river wash," is superior to that obtained from surface pits and called "rain wash." Mining is with handtools. Where pits must be sunk, windlasses are used for hoisting. In Kayabasi fist-size emery is strewn over a high limestone plain. A considerable quantity of emery is also obtained from freshly plowed fields.

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Fertilizer Raw Materials

Turkey is not endowed with raw materials for manufacturing potash and phosphate fertilizers, although the possibility of finding phosphatic limestone is not ruled out. Pyrite recovered from the Ergani mine and sulfur-bearing furnace gases from Ergani and Murgul copper smelters, as well as native sulfur, are available for manufacturing sulfuric acid for the production of ammonium sulfate and superphosphate fertilizers. A 200-ton-per-day sulfuric acid plant is being constructed in Murgul. The sulfuric acid will be transported by pipeline to boats for delivery to 2 superphosphate plants, each of 100,000 tons annual capacity, in Iskenderun and Trabzon. The plant at Trabzon is under construction, but the Iskenderun plant came into operation in early 1954. Sulfuric acid for this plant is imported from Israel in exchange for pyrite from the Ergani copper mine shipped to Israel.

Gypsum will be used as a fertilizer raw material in the plant of Azot Sanayii T.A.Ş. being built at Kütahya. The plant will produce 35,000 tons of ammonia yearly, which will be used to manufacture 60,000 tons of ammonium sulfate and other products. The 100,000 tons of gypsum requirement will be obtained from extensive deposits in Beçer and Salizar in Eskişehir Il east of Kütahya.

Ammonium sulfate and superphosphate are manufactured at the Karabük steel plant. The ammonia is obtained as a byproduct of the coke ovens, but the superphosphate (16 to 18 percent P_2O_5) is made from phosphate rock imported from north Africa. (See under Karabük.) Information on the current rate of superphosphate production in the Iskenderon plant is not available.

Fire Clay

Refractory clay slate in the footwall of coal beds belonging to the Karadon series of the Zonguldak coalfield supply the raw material for the Filyos refractory plant. In the western coalfield one deposit occurs in lower Kiliç Valley, south of Kozlu. Another deposit, worked since 1952, is near Karadon coal mine. This mine has 3 beds, respectively 0.5 - 1.5, 1.4, and 0.6 m. The most important deposit in the eastern coalfield is Tarlaağzi west of Amasra. Total reserves are 850,000 tons of clay and 60,000 tons of quartzite.

Fluorspar

The reported production of fluorspar (115 tons in 1946, 500 tons in 1949, 251 tons in 1952, 100 tons in 1953, and 20 tons in 1955) is believed to have come from 1 or a group of deposits near Şehri Çedit, Çiçekdağ County, Nevşehir Il. Information on reserves and the grade of ore in these deposits is not available. West of km. 229 of the Ankara-Kayseri Railroad near the village of Çangili, a vein of fluorite 70 to 75 cm. thick occurs in a granite. Other minerals in the vein are calcite, quartz, also inclusions of zircon, and rarely topaz and titanite. The granite country rock belongs to a number of small or large granite outcrops found in the triangle Yozgat-Keskin-Kirşehir. The fluorspar is weakly radioactive.

Fluorspar as a subsidiary mineral to sulfides occurs southwest of Sivas, at Divriği and at Keban, but it is not known whether they have potentiality for economic production. Fluorspar prospects have also been reported in Lalapaşa in Edirne Il and in the area of Manisa-Demirci-Pulluca.

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Kaolin

According to Ryan's Guide (44), 32 kaolin deposits occur in 14 Provinces, among them Istanbul, Çanakkale, Balikesir, Manisa, Izmir, and Eskişehir. The occurrences are small, and no information is available on the quality of the kaolin.

Magnesite

Several magnesite deposits have been found in the Taştepe district of the Eskişehir Il near Basören, Gündüzler, Margi, and Sepetçi. Other deposits occur near Sakaköy (Kütahya Il), Bozüyük (Bilecik Il), Topuk (Bursa Il), Cumali (Denizli Il), and Göcekler (Icel Il). Eluvial massive magnesite is reported at the village of Aşağı Kuzfindik, 32 km. N.N.E. of Kütahya. South of Taşköprü valley, serpentine mountains are laced with magnesite for a distance of 3 to 4 km. The magnesite resulted from weathering of serpentine rock. Magnesite content of Taştepe deposits varies from 43 to 46 percent. The quantity mined has varied considerably from year to year. Mining is by the open-pit method, and most of the output is exported.

Meerschaum

Turkey is the source of most of the world's production of meerschaum. The material occurs as small lumps and masses in residual clays derived from serpentine in the Taştepe area of Eskişehir; 31 deposits occur near Basören, Kokceoğlu, Imşehir-Karatokat, Söğutcük, Margi, Sepetçi, and Gazigöl. The deposits are worked sporadically by local villagers who obtain concessions. The material is won by driving shallow pits until a seam of meerschaum is struck and following it by driving drifts. The depth of working is limited by the ground-water level. Annual production (table 1) is a few hundred to several hundred cases, each containing 40 kg. of meerschaum. A considerable percentage of the output is exported to Austria, Germany, the United Kingdom, and the United States. The remainder is used in Turkey for making pipes and souvenir articles.

Preliminary treatment of meerschaum consists of removing dirt, drying, and polishing. The polished material is sorted into 7 grades, 6 of which are known as lager, grosse baumwolle, kleine baumwolle, polierte kasten, geputzt, and ciliz. The 1950 price of the lager grade in Europe was $210 per case.

Salt

Production and Consumption

Salt production in Turkey averaged about 251,000 tons annually during the decade before 1950 and 374,000 tons in the 7 years after 1949. The significant increase in production after 1952 must be attributed to expansion of capacity of two major salt-producing pans at Çamalti and Yavşan, brought about by ECA aid. The production target of 440,000 tons a year was exceeded in 1955. Annual consumption of salt in Turkey is 260,000 to 300,000 tons. Of this, 20,000 tons is consumed by industry and the remainder for culinary purposes.

Over 90 percent of Turkish salt is obtained from brine (see table 29). Rock-salt production amounts to about 25,000 tons annually and is obtained from several small mines, each producing a correspondingly small tonnage. Salt for domestic consumption is produced by the Turkish Salt Monopoly, which is under the control of the Ministry of Customs and Monopolies, but salt recovery by private firms for export is permitted; however, the Monopoly inspects the salt before it is exported to assure adherence to quality standards.

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The expansion of Çamalti and Yavşan salt pans to a target production capacity of 440,000 tons a year was based on the recommendations of a firm of consulting engineers that examined the pans in 1949. They concluded that in Çamalti the increase could be achieved partly by expanding the crystallization area and partly by producing more salt per unit of crystallization area. The larger production per unit area was achieved by increasing the number of days available for water processing and salt-strata deposition through mechanization. Mechanization would save 15 days in soil-surface preparation time and allow harvesting to be carried out 15 days later, thus making an extra total of 30 days available per season for salt deposition. Some $2,000,000 of ECA aid was allotted for this purpose and an order was placed for the necessary equipment.

TABLE 29. - Production of salt in Turkey, 1940-55
(Metric tons)

Year	Brine				Rock salt	Total salt
	Çamalti	Yavşan	Springs	Total		
1940	131,715	29,457	32,041	193,213	19,621	212,834
1941	163,096	18,400	-	181,496	22,350	203,846
1942	156,215	19,027	27,619	202,861	22,105	224,966
1943	169,848	22,784	50,721	243,353	22,976	266,329
1944	146,912	29,013	(1)	(1)	(1)	266,330
1945	169,869	14,362	71,072	255,303	16,193	271,496
1946	155,428	-	30,661	186,089	20,215	206,304
1947	174,382	35,189	40,044	249,615	26,494	276,109
1948	166,637	35,602	36,519	238,758	27,403	266,161
1949	191,674	59,940	43,192	294,806	24,308	319,114
1950	182,140	66,204	38,712	287,056	23,117	310,173
1951	162,078	54,301	33,612	249,991	22,659	272,650
1952	154,187	94,198	43,205	291,590	31,533	323,123
1953	(1)	(1)	(1)	358,500	27,000	385,500
1954	(1)	(1)	(1)	416,000	26,000	442,000
1955	(1)	(1)	(1)	480,000	(1)	(1)

1/ Not available.

Marketing and Export

The salt monopoly is only in production; the salt is sold and distributed by private firms and individuals. Salt is purchased by merchants at the salinas at a fixed price, packaged, and resold to the public at a price based on purchase price plus transportation and profit. In some remote areas of the country, transportation increases the price of salt considerably. The cost of production is estimated at TL 6 ($2.15) per ton. The Government derives revenue from the sale of salt.

Exports of salt during 1938 to 1956 are given in table 30. They dropped to virtually nil during World War II but were resumed in 1946. Japan has been the most important buyer, although Italy, Yugoslavia, Spain, Bulgaria, and Israel have also purchased salt from Turkey at times. The value of salt exports during 1951-52 and 1955-56 and export value per metric ton were as follows:

Year	Total value	Value per metric ton
1951	TL 693,400	TL 8.9
1952	TL 707,013	TL 8.5
1955	TL 101,805	TL 6.2
1956	TL 367,324	TL 6.6

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At the production rate achieved in 1955, Turkey will have an export surplus of 140,000 to 180,000 tons. Whether it will be able to market all this surplus depends on loading and shipping costs, which influence to a large extent the competitive sale price of salt in world markets.

TABLE 30. - Salt exports from Turkey, by countries of destination, selected years
(Metric tons)

Source: 61.

Year	Yugoslovia	Japan	Other	Total
1937	14,432	89,306	-	103,738
1938	6,000	43,688	7,000	56,688
1939	-	102,435	1,215	103,650
1940	11,126	-	-	11,126
1946	22,942	-	1/ 30,627	53,569
1947	35,656	-	-	35,656
1948	-	19,345	2/ 9,854	29,199
1949	-	39,679	2/ 9,150	48,829
1951	-	75,195	3/ 2,610	77,805
1952	-	76,328	3/ 6,370	82,698
1955	-	-	4/ 16,409	16,409
1956	27,830	13,441	14,530	55,801

1/ Italy.
2/ Spain.
3/ Israel.
4/ Bulgaria, 9,500 tons; Spain, 6,909 tons.

All salt destined for export comes from the Çamalti salina because of its favorable location. The importer usually buys the salt at the salina and ships it in vessels owned or contracted by it. Export sales are handled by a separate division of the monopoly, which is responsible for foreign sales of all monopoly commodities.

Çamalti Salina

Because of its location on the Aegean coast, Çamalti supplies salt to all areas that can be reached by coastal shipping and is the most important salt-producing unit. A 168-meter loading pier is used for gravity loading of lighters. The salt is transported in 100-ton wooden lighters to cargo ships that have to anchor 1-1/2 to 4 km. out at sea, depending on the tonnage. About 1,600 tons can be loaded in an 8-hour period, but the shorter winter days and inclement weather reduce this rate. Land shipments are over a 14-km. truck road that connects the salina with the main road to Izmir dock, a distance of 37 km.

The salina is situated along a 4-km. stretch of the coast from 1-1/2 to 2 km. inland and on the seaward portion of a gradually sloping plain, which begins at the foot of the Menemen Mountains. It is composed of a series of interconnected diked sections, with inflow and outflow gates interspersed to facilitate water transfer and circulation. Solar evaporation and breeze increase the density of the sea brine, 3.5° to 4° B., to 25° B. as the brine circulates in shallow, diked-in ponds. The area of these ponds is about 5,000,000 $m.^2$. The 25° B. brine is introduced into the crystallization section, of nearly 1 million sq. m., where salt stratification takes place. When the density in the crystallization section exceeds 25.5°, the bittern is pumped out into the sea and replaced with fresh brine. This is repeated about 30

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times between June 1 and September 1, during which period a total thickness of 12 or 13 cm. of salt accumulates.

Harvesting - loosening of the stratified salt and putting it in small piles for draining before transportation - was formerly done by manual labor and required a large number of men. However, machines may have replaced manual labor at present. The normal harvesting period is between September 15 and October 15. The salt is loaded into small mine cars, which are run over temporary tracks in the crystallization area. After harvesting, fresh sea brine is pumped into the crystallizing section, where it remains 7 to 10 days to cleanse the bed. This brine is then pumped off and the surface allowed to dry. Chemical analysis of sea water from Çamalti and of the salt produced is shown herewith.

Çamalti brine and product analyses

	Brine, grams per liter	Salt, percent
$CaSO_4$	1.989	0.97
$MgSO_4$	2.370	.73
$MgCl_2$	3.650	1.44
NaCl	36.27	96.54
Insoluble	-	.07

Yavşan Salina

Yavşan salt is derived from the salt lake of Tuzgölü, which during the wet season (approximately mid-November to mid-April) has a surface area of 1,750 sq. km. Operations are near Cihanbeyli and in Kaldirim near Koçhisar. The brine has 18° B. density during the rainy season, but solar evaporation and breeze raise the density to the precipitating point, and salt stratification begins on or about April 15, attaining 15 to 18 cm. (5 to 6 inches) by August 15. The lake dries between July 15 and August 1, leaving a layer of salt 6 to 20 cm. thick, and remains dry until the beginning of the rainy season. Harvesting is therefore done on a solid surface and lasts 2-1/2 to 3 months, depending on the weather. Theoretically, the productive area is the area of the lake itself (1,750 sq. km.), provided replenishment incidence over the whole lake is similar to that experienced over the limited area (1 sq. km. from the lake shore) now utilized.

Yavşan salt is free from dirt and has the following approximate composition on a dry basis, in percent: Insoluble, 0.52; $CaSO_4$, 1.00; $CaCl_2$, 0.11; $MgCl_2$, 0.19; NaCl, 98.68. After harvesting, the salt is loaded by hand into 1-ton cars, which are hauled by steam locomotives over temporary tracks laid on the salt surface. From the high-water mark of the lake a permanent narrow-gage railway, 6 km. long, connects with the compound at Yavşan.

Diesel locomotives pull trains of salt over this permanent track to Yavşan, where the salt is stored in a big pile. Temporary tracks are taken back to Yavşan to be cleaned and oiled before storage.

Daily production during harvesting is about 1,000 tons, and production cost (1953) is TL 6 per ton. Transportation is the limiting factor in an expanding production. A 22-km. trail connects Yavşan to the Ankara-Konya road at Cihanbeyli. Trucks can move over this trail only during the short period during winter, when the mud is frozen. At other times the salt is transported on animals and in carts. It is sold by the monopoly at Yavşan, the purchaser arranging his own transportation, which may amount to TL 15 to Konya.

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The Yavşan compound has living quarters, a school, and a dispensary for the permanent staff. Equipment consists of diesel and steam locomotives, mine cars, a repair shop, and a small powerplant. Drinking water is piped in from a village about 22 km. from Yavşan.

Sulfur and Pyrites

Sulfur mining is a comparatively old industry in Turkey. The principal deposit at Keçiborlu in Isparta Il, southwest Turkey, was developed by the Germans during World War I. From 1933 to 1943 the mines were under joint private and Government ownership, but they were taken over by the Eti Bank in 1943 as a State enterprise. Production from Keçiborlu during 1939-49 averaged about 3,043 tons of commercially pure and dusting sulfur (65 percent S) but increased to an average of 9,564 tons for the succeeding 7 years and to a maximum of 13,900 tons in 1956. The increase since 1950 has been attributed to discovery of a new ore body and operation of the flotation plant at Keçiborlu, which has an annual capacity of 14,000 tons. The accompanying table of sales by the Keçiborlu Kükürt Fabrikasi, the Eti Bank subsidiary in charge of sulfur production, and of imports indicates that domestic consumption averaged nearly 5,000 tons a year during the period 1943-50. In view of the country's agricultural and industrial development, the present consumption must be about 7,000 to 8,000 tons a year.

Sulfur statistics (in metric tons)

Year	Domestic sales	Imports	Consumption
1943	2,527	0	2,527
1944	4,539	405	4,944
1945	3,690	1,009	4,699
1946	524	3,801	4,325
1947	1,092	6,684	7,776
1948	2,619	2	2,621
1949	5,204	2,283	7,487
1950	4,715	132	4,847

Turkey is now more than self-sufficient. The bulk of the sulfur is used in vineyards for agricultural purposes. Prices per metric ton, f.o.b. railroad cars at Keçiborlu, during 1950 and 1951 were as follows: Sulfur in blocks, TL 300 ($107); ground sulfur, TL 280 ($100); ground concentrate, TL 178 ($64).

Demand caused by world shortage brought Turkish sulfur into the export market for the first time in 1951 at prices ranging from TL 28 to TL 50 ($10 to $17.85) for a 50-kg. bag of ground product, f.o.b. Istanbul. Between January and May 1951, 1,529 tons of sulfur was exported to The Netherlands, United Kingdom, India, Ireland, and South Africa, but exports were banned in 1951 to safeguard domestic supply. This ban is no longer in force, and, in 1955 and 1956, 850 and 5,500 tons of sulfur, respectively, was exported, valued at TL 190,400 and TL 1,232,000.

The formations in the Keçiborlu region are massive limestone of Triassic or Jurassic age, Eocene flysch, and green rocks. These are traversed by a rhyolite dike, which can be followed for 10 km. The rhyolite has transformed the Mesozoic limestone into a silicified rock. The sulfur, accompanied by marcasite and pyrite, is of volcanic origin and occurs exclusively in the rhyolite. Mining has been carried out in Değirmendere and Kükürt Deresi. Ancient workings are to be seen in

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Kaynak Deresi and in Kömürdere. These localities are oriented southwest-northeast, one of the tectonic directions in this part of Taurus. It is implied that the principal deposits are found where the rhyolite is crossed by faults.

The Keçiborlu mines lie a few miles from the town of Keçiborlu, on the railroad from Afyon to Isparta in the Isparta Il. Reserves are estimated at 1 million tons of ore, with a sulfur content between 10 and 60 percent. Present mine production is mainly from the Değirmendere area.

To improve recovery and lower production costs, a flotation plant built by the German firm Humboldt Deutz has been erected. It has a capacity for treating 100 tons of ore per 24 hours and an annual capacity for producing 14,000 tons of 95 percent pure sulfur from 30,000 tons of ore. Before the flotation plant was installed, the ore was hand-sorted and refined by fusion in steam autoclaves near the Keçiborlu railway station. About 50 percent of the sulfur contained in the ore was recovered as 99.8- to 99.9-percent sulfur in blocks. The residue was milled (65 to 70 percent S content) and sold to vineyards.

Another sulfur-bearing area, which has been worked intermittently, is near the villages of Teke and Tirkaz, 10 km. southwest of Sarayköy railway station in Denizli Il. A dry-weather road running parallel to the south bank of the Büyük Menderes River connects Sarayköy to the mineral area, and the east-west Izmir-Denizli rail line lies 3 km. to the north. The sulfur is of volcanic origin and occurs as irregular masses in limestone faults. The deposits have been worked fairly extensively near the surface. Further exploration would require mine development at depth.

In the same Il, near Çambaşe in Denizli County, are 2 workable deposits, 1 with a probable reserve of 10,000 tons. Other sulfur deposits are reported at the following localities: Sariköy near Taş in Balikesir Il; and Örendere near Pulluca, Demirci County, in Manisa Il. Both are considered of possible economic interest.

Existence of pyrites in the Ergani and Murgul copper ores has already been mentioned. In addition, pyrites is reported to occur in the following localities:

Il	County	Locality
Kastamonu	Küre	Asiköy.
Artvin	Sungurlu	Elmali, close to Artvin and near to Çavuş.
Niğde	Aksaray	Near Gelveri and at Yakacik.
Ordu	Fatsa	Near Telpeköy and Gömecek.
	Ünye	Near Kuşculu.
Gümüşhane	Ardasa	Near Manistir.
Rize	Çaybaşi	Near Madenköy.
Siirt	Kürfre	Near Destutvuran.
Giresun	Tirebolu	Near Karaerik.

The Küre deposit, 18 miles inland from the Black Sea port of Inebolu, is a massive pyrite carrying some copper. The deposit has a measured reserve of 1.6 million metric tons and inferred reserves of 10 million tons. A subsidiary of Eti Bank is working this property. The tonnage and grade of other deposits are not known.

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CONSTRUCTION MATERIALS

General

Data on the production and consumption of construction materials (other than cement) and information on the nature and location of deposits are rather scant. Resources of limestone, granite, and other hard rocks for building stones and of clays for manufacturing brick are ample and widespread. Similarly, sand and gravel probably occur in all parts of the country, but information on the location of specific quarries and the nature of their products is not available. Marble occurs in large quantities in northwestern and southwestern Turkey and in the vicinity of Kirşehir and Eskişehir.

Imports of construction materials (other than cement) into Turkey are very modest and consist of cut stones, chalk, and ceramic and refractory clays.

Cement

Resources of limestone, clay, marl, and shale suitable for manufacturing portland cement are abundant. Gypsum also occurs in north-central Turkey and in Sivas area.

Production

Cement production during 1944-56 is tabulated below, in metric tons, showing a continuous increase; production by individual plants is shown in table 31.

1944 285,348	1949 375,522	1953 530,872
1945 288,455	1950 395,630	1954 703,291
1946 323,219	1951 396,316	1955 819,307
1947 349,895	1952 459,073	1956 970,039
1948 344,058		

Based on 1938 production as 100, the 1956 index of production was 360. The total productive capacity in 1950 amounted to 395,000 metric tons but rose to 1,030,000 tons at the end of 1954 and 1,380,000 tons in 1957. Completion of new plants under construction or contract (see below) will bring the total capacity to 2,680,000 metric tons. Plants operating in 1957, their location, capacity, and the country of origin of the equipment are shown in table 32.

The output in 1954 and 1955 was, respectively, 68 and 77 percent of the rated capacity. Meager coal supply, lack of spare parts, and inadequate transportation for hauling coal to the plants were the reasons for not achieving capacity production. In 1944 plants of the Sumer Bank, which are completely State-owned, produced 67.3 percent of the total output. However, the share of State-owned plants has decreased considerably, as is shown in the 1948-56 figures in table 31.

Consumption and Trade

The cement shortage has been particularly acute during the last decade, when Turkey has been engaged in a large program of development and construction. Consumption, considerably more than domestic production, increased from about 550,000 metric tons in 1950 to about 1,619,000 in 1955, of which nearly half was imported. The 1956 consumption was 1,262,316 tons, of which 293,245 tons was imported. There was considerably less construction in 1956, which accounts for the reduced consumption.

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Cement imports for 1945-56 (see table 33) increased rapidly from 2,206 tons in 1945 to 810,787 in 1955 and averaged 521,803 during 1951-55. In the same period the annual cost of cement imports rose from TL 132,369 in 1945 to TL 51,899,611 in 1955.

TABLE 31. - Production of cement in Turkey, by plants, 1948-56
(Metric tons)

Plant	Sector	1948	1949	1950	1951	1952
Sivas	State	91,328	100,043	86,174	61,508	171,735
Kartal	Private	99,650	116,600	139,320	135,120	121,360
Zeytinburnu	do.	104,733	107,801	114,905	122,493	112,552
Darica	do.	35,964	36,242	42,685	44,003	39,851
Ankara	State	12,383	14,836	12,546	13,200	13,575
Izmir	Private	-	-	-	-	-
Percent of state production		30	31	25	19	40
Total		344,058	375,522	395,630	396,316	459,073

Plant	Sector	1953	1954	1955	1956
Sivas	State	178,196	155,874	149,177	180,224
Kartal	Private	127,914	115,802	151,100	149,647
Zeytinburnu	do.	118,419	155,940	180,086	190,611
Darica	do.	41,184	121,670	183,500	261,291
Ankara	State	13,311	-	-	40,175
Izmir	Private	51,848	154,005	155,445	148,091
Percent of state production		36	22	18	23
Total		530,872	703,291	819,307	970,039

TABLE 32. - Cement plants in operation in Turkey, 1957

Location	Number of units	Date operation began	Capacity,[1] metric tons	Source of equipment[2]	Ownership
Ankara	2	1956	120,000	Humboldt	Sümerbank (State).
Darica (Izmit)	3	1954	200,000	do.	
		1956	100,000		Aslan, Çimento Şirketi (Private).
			300,000		
Eskişehir	1	1957	150,000	Miag	Private.
Izmir	1	1953	150,000	Smidh	Do.
Kartal		1932	120,000	do.	
(Istanbul)	1	1954	120,000		Anadolu Çimentotari Türk Anonim Şirketi (Private).
			240,000		
Sivas	1	1943	100,000	Humboldt	Sümerbank (State).
		1952	100,000		
			200,000		
Zeytinburnu	1	1932	120,000	do.	Türk Çimentosu ve Şu Kireci Anonim Şirketi (Private).
		1954	100,000		
			220,000		
			1,380,000		

1/ All plants have the wet process except 1 of the Ankara plants, which has the dry process. Other than the Izmir plant, which uses lignite, others use coal.
2/ Humboldt and Miag are German; Smidh is Danish.

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TABLE 33. - Cement imports into Turkey, 1945-56
(Metric tons)

Source: 61.

Year	Portland	Natural	White	Other	Total	Value
1945	1	2,180	25	-	2,206	132,369
1946	270	251	-	21	542	54,272
1947	2,578	150	509	-	3,237	317,662
1948	88,200	9,472	822	-	98,494	7,417,785
1949	18,111	6,448	1,697	2	26,258	1,994,065
1950	120,354	12,449	2,136	7	134,916	7,341,403
1951	233,516	5,561	4,050	141	243,268	17,549,355
1952	380,040	4,192	5,005	230	389,467	29,132,977
1953	529,196	-	7,084	528	536,808	34,606,419
1954	613,644	13,316	1,727	-	628,687	39,255,199
1955	764,248	39,520	7,012	7	810,787	51,899,611
1956	280,075	-	6,830	6,340	293,245	22,479,492

New Plants

To cut down the need for imports, the Government fostered an expansion program in 1950, with the following accomplishments (see also table 32):

1. The capacity of the Sivas plant was increased 100,000 tons in 1952.

2. A new 150,000-ton plant was established in 1953 in Izmir.

3. The old Darica mill (40,000-ton capacity) was replaced by three 100,000-ton units, which were put in operation during 1954-56.

4. The capacity of the Zeytinburnu plant was extended by a 100,000-ton unit in 1954.

5. Two units (85,000- and 35,000-ton) were put in operation in Ankara.

6. A plant with 150,000-ton capacity was erected at Eskişehir.

In 1952 plans were drawn for constructing additional plants in scattered parts of the country to obviate the need for hauling cement long distances. A holding company, Cement Industry Corp. of Turkey (Türkiye, Çimento Sanayii, T.A.Ş.), was organized, with a capital of TL 50,000,000, subscribed by private bank and 2 Government banks. The capital was increased to TL 100,000,000 in 1956. The corporation has contracted (on the basis of 5-year credit) to construct the following 12 plants, proceeding from west to east:

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Location	Fuel to be used	Principal machinery supplier	Scheduled completion date	Capacity 1,000 tons 1/
Pinarharsar	Lignite	Krupp	December 1957	85
Söke	do.	Fives-Lille	December 1958	85
Balikesir	do.	Humboldt	December 1957	85
Afyon	do.	Fives-Lille	do.	85
Bartin	Coal	do.	December 1958	150
Niğde	Lignite	Krupp	July 1958	85
Çorum	do.	Fives-Lille	December 1957	85
Adana	Coal or lignite	Humboldt	March 1957	150
Gaziantep	Oil	Krupp	December 1957	85
Elasiğ	do.	do.	do.	85
Batman	do.	do.	do.	85
Erzurum	Lignite	Ansaldo	?	85
Total				1,150
Existing capacity in operation				1,380
Private plants under construction at Afyon				150
Total of projected capacity				2,680

1/ All wet-process plants except Adana and Balikesir.

All these plants are believed to be near necessary raw materials and lignite deposits when this fuel is to be used. Fuel oil for plants at Gaziantep, Elaziğ, and Batman will be obtained from the new refinery at Batman. The estimated cost of the 12 new plants was TL 221,000,000, with an additional TL 17,000,000 for power-plants and feeder lines. Each of the above plants is to be owned jointly by the above corporation and private participants in each locality concerned. It is estimated that ultimately the Turkish cement plants will save the country annually an equivalent of TL 80,000,000 in foreign exchange and nearly half as much in internal distribution costs.

The planned capacity is considerably larger than the maximum level of consumption achieved in 1955. Presumably a long-range rise in consumption is expected; whether the rise can absorb all the cement produced by new plants remains to be seen.

Prices

In 1955 Istanbul c.i.f. prices for imported cement were, for portland cement, TL 63, and for white cement, TL 135 per ton. The price of locally produced cement is set by the Ministry of Economy and Commerce. The f.o.b. factory price was: Sivas TL 72, Izmir TL 75, and Ankara TL 80 and TL 67 a ton at Darica, Zeytinburnu, and Kartal.

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APPENDIX I - MINOR TURKISH PORTS USED OCCASIONALLY FOR ORE LOADING[9/]

(Auxiliary Ship-Loading Facilities in Turkey)

Mediterranean

Antalya — Daily loading rate: 350 tons by lighters. Open roadstead can handle harbor vessels under 500 tons. A chute conveys ore from a dump, 10 m. above water level, to lighters. Loading during December to February to be avoided.

Fethiye — Daily loading rate: 900 metric tons. Sheltered roadstead; vessels anchor 0.4 to 1.5 km. from shore. Special lighters used for carrying ore-filled cars or tubs avoiding necessity of emptying ore in lighters. Conveyor also used for ore loading.

Göcek — Daily loading rate: 750 tons. Sheltered by 2 wooden and I-beam jetties; vessels can anchor 300 m. from shore. Ore is moved to jetty (60 m.) by small cars running on narrow-gage track and loaded into lighters by dumpers. Ships cannot be loaded during December to February.

Marmaris — Daily loading rate: 500 to 600 tons. Open roadstead, well-protected; vessels must anchor 3/4 to 1-1/2 km. from shore. Of 2 loading points only 1 has a small wooden jetty. Ore is put into burlap bags and loaded in lighters. These bags are emptied into buckets lowered from ship. Dump is 30 to 45 m. from jetty.

Sea of Marmara

Bandirma — Daily loading rate: 500 tons by lighter. Open roadstead and protected area for smaller vessels. L-shaped, reinforced-concrete jetty. Ore discharged into lighters by wheelbarrow or by wooden chutes from railroad cars. During July and September, when NNE. winds predominate, lighter loading becomes difficult.

Derince — Daily loading rate: 650 tons. Exposed railroad concrete pier, with room for 3 vessels. Ore must be loaded on railroad cars from a dump 200 m. from the pier and brought alongside ship for loading by ship's gear. Port has no lighter loading facilities.

Mudanya — Open roadstead. Two concrete ore dumps available. A jetty is built in front of 1 dump. Loading difficult during December and January.

Black Sea Ports

Amasra — Daily loading rate: 400 tons. Amasra is a small harbor in sheltered bay and has 1 jetty 30 m. by 6. Behind jetty is 1,500 sq. m. of space for a dump, but shore has unlimited storage space. Nearest railroad station is Kokaksu, 52 km. distant. Chrome ore is brought from the neighborhood of Bartin. Loading in January and February would be difficult.

9/ As of 1952.

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Ereğli	Daily loading rate: 400-500 tons. Sheltered deep-water harbor. Ships anchor near breakwater in 18 m. of water. There is a concrete pier (75 by 3.50 by 3.50 m. deep), and a wooden ore jetty (30 by 2 by 3.50 m.); another stone pier is under construction. 2 storage areas, capacity 3,500 and 5,000 tons. Distances from dumps to jetty are 50 and 175 m. respectively; ore is moved from dump areas to jetties in small wagons.
Giresun	Sheltered bay created through promontory of Giresun, which projects into sea. Small stone pier in this harbor is used for loading and unloading passengers and cargo. Behind this pier is a limited space for ore storage.
Inebolu	Open roadstead, very exposed; new harbor under construction. Ships may anchor 300 to 500 m. from shore in good weather and 1.5 km. from shore during bad weather. A concrete pier is under construction but is not for use of ore shippers. Ore is usually moved from storage dump in wooden boxes on backs of stevedores and emptied in lighters.
Filyos	Exposed open roadstead. Ships may anchor 375 m. from shore for loading during good weather and 1 km. in rough weather. A concrete pier 130 by 25 m. belongs to railroad. Unlimited storage space on sandy beach. Ships cannot be loaded in October-March.
Sinop	Well-protected bay; harbor is used as refuge during Black Sea storms.
Trabzon	Port fully sheltered in all weather; consists of still-water area created by 2 breakwaters. Vessels of 6,000 to 7,000 tons have anchored in harbor.
Ordu	Open roadstead, somewhat protected, but substantially an open beach. Port has several small jetties. Ore could be loaded at Ordu, preferably aboard smaller vessels coming near shore.

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